A STUDY ON OUTCOME OF MEDIAL OPEN WEDGE OSTEOTOMY USING PUDDU PLATE FOR UNICOMPARTMENTAL OSTEOARTHRITIS OF KNEE

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BRANCH – II (ORTHOPAEDIC SURGERY)

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CHENNAI, TAMILNADU

CERTIFICATE

This is to certify that this dissertation entitled "**A STUDY ON OUTCOME OF MEDIAL OPEN WEDGE OSTEOTOMY USING PUDDU PLATE FOR UNICOMPARTMENTAL OSTEOARTHRITIS OF KNEE**" is the bonafide work done by Dr. R.VETRI NALLATHAMBI, under my supervision in the Department of Orthopaedic Surgery, Madurai Medical College, Madurai-20.

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DECLARATION

I, **Dr. R.VETRI NALLATHAMBI**, solemnly declare that the dissertation titled "**A STUDY ON OUTCOME OF MEDIAL OPEN WEDGE OSTEOTOMY USING PUDDU PLATE FOR UNICOMPARTMENTAL OSTEOARTHRITIS OF KNEE",** has been prepared by me. This is submitted to **The Tamil Nadu Dr. M.G.R. Medical University, Chennai,** in partial fulfillment of the regulations for the award of M S degree branch II Orthopaedics.

Place: Madurai

Date : **Dr. R.VETRI NALLATHAMBI**

CONTENTS

INTRODUCTION

Worldwide one out of four human beings had already developed or will develop osteoarthritis in the future. In 2020, osteoarthritis will rank number four for reasons for permanent invalidity worldwide. About one third of the patients scheduled for total joint replacement of the knee are potential candidates for an osteotomy.

The fundamental principles of osseous deformity correction were defined by Friedrich Pauwels in 1964 and Paul Maquet in 1976. Since then, many techniques have been developed for osteotomies around the knee. Mark Coventry published his technique for closed wedge osteotomy in 1965, which became the gold standard for many years. The success of an osteotomy around the knee depends on the biomechanics of the lower extremity, Wolff's law of continuous transformation of bone under stress, load distribution in knee and also on the mechanical property of the implants used for osteotomy fixation.

Osteotomies around the knee have had a significant complication rate in the past and many surgeons abandoned these procedures although the favourable long term results were well known. The main problems were the intraoperative choice of the correction angle and the risk of a

postoperative loss of correction. After many years of closed-wedge osteotomy, open wedge valgization osteotomy has become popular.

The experience and the development of new techniques for axis correction around the knee have led to its revival. 90% of all osteotomies around the knee are for valgization of tibia (high-tibial osteotomy = HTO). Whereas in the past closed-wedge osteotomy from the lateral side with fibula osteotomy was the gold standard in many countries; and in 1990s fixation plate by Puddu came to vogue. This procedure looked very attractive to many surgeons because of the small incision and the simple surgical steps.Open-wedge osteotomy of the tibia can be performed without bone grafting or bone substitution in most cases.

In this study we analyse the outcome of open wedge osteotomy in patients having unicompartmental osteoarthritis with genu varum using the puddu plate.

AIM & OBJECTIVES

AIM :

The aim of the study is to analyse the effectiveness of Medial open wedge osteotomy using puddu plate in patients with Unicompartmental Osteoarthritis.

OBJECTIVES :

(a) To study the effectiveness of medial open wedge osteotomy using puddu plate in relieving knee pain in patients with Unicompartmental Osteoarthritis.

(b) To study the functional outcome in these patients.

(c) To show that bone grafting is not necessary.

REVIEW OF LITERATURE

KNEE JOINT :

The knee joint fascinates everyone with its complexity. It has the femur and tibia articulating with each other and the patella which glides over femur.

Articulation :

Above are the rounded condyles of the femur; below are the condyles of the tibia and their cartilaginous menisci; in front is the articulation between the lower end of the femur and the patella[1].

The articular surfaces are covered with hyaline cartilage. Note that the articular surfaces of the medial and lateral condyles of the tibia are often referred to clinically as the medial and lateral tibial plateaus[1].

Type :

The joint between the femur and tibia is a synovial joint of the hinge variety, but some degree of rotatory movement is possible. The joint between the patella and femur is a synovial joint of the plane gliding variety[1].

Capsule :

The capsule is attached to the margins of the articular surfaces and surrounds the sides and posterior aspect of the joint. On the anterior aspect of the joint, the capsule is absent, permitting the synovial membrane to pouch upward beneath the quadriceps tendon, forming the suprapatellar bursa. On each side of the patella, the capsule is strengthened by expansions from the tendons of vastus lateralis and medialis. Behind the joint, the capsule is strengthened by an expansion of the semimembranous muscle called the oblique popliteal ligament. An opening in the capsule behind the lateral tibial condyle permits the tendon of the popliteus to emerge[1].

Tibia :

The tibia is the large weight-bearing medial bone of the leg. It articulates with the condyles of the femur in the knee.The lateral condyle possesses on its lateral aspect a small circular articular facet for the head of the fibula. The semimembranosus muscle inserts posteriorly in medial condyle[1]. The tendons of Sartorius, Gracilis and Semitendinosus insert in the proximal shaft in medial aspect and the pes anserinus bursa is present between them. At the junction of the anterior border with the upper end of the tibia is the tuberosity, which receives the attachment of the

ligamentum patellae. This tibial tuberosity with its ligamentum patellae is very important for extension of the knee.

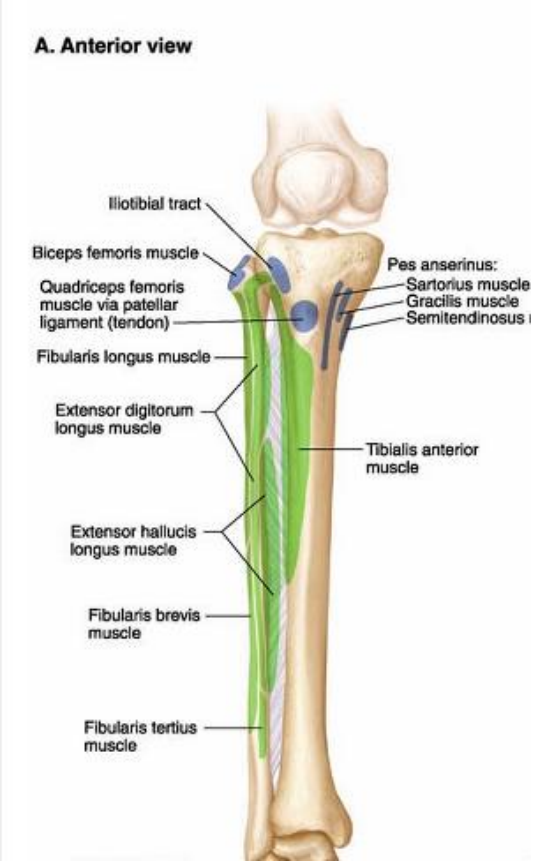
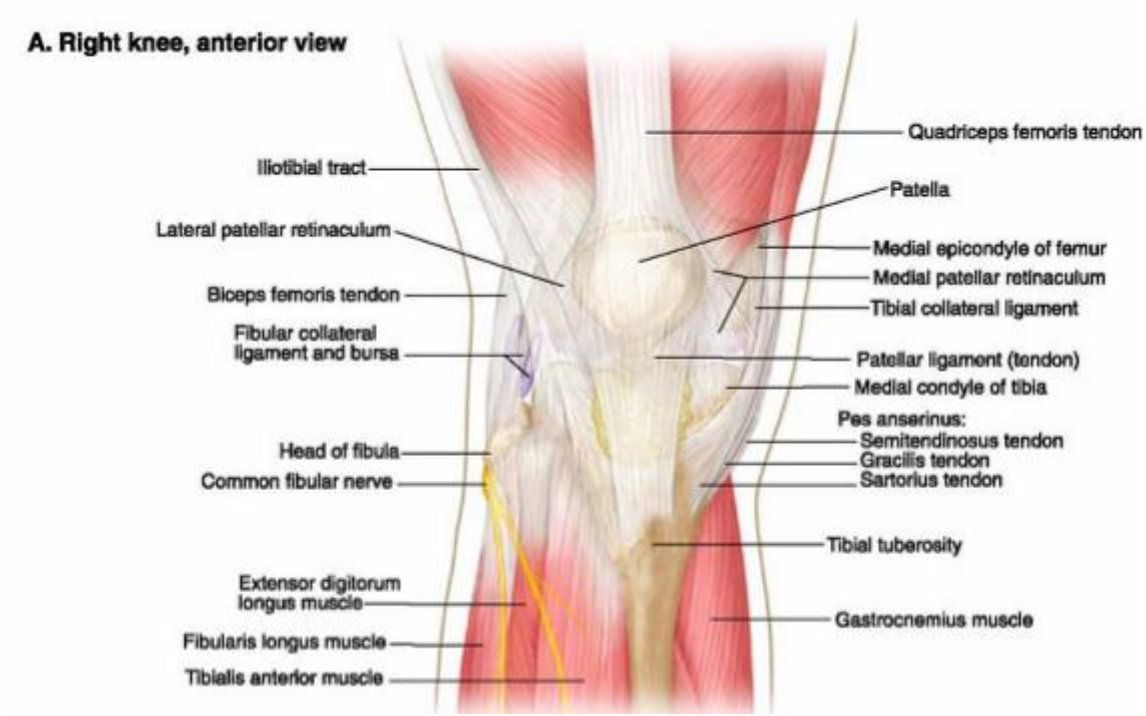


Fig 1 : Muscular attachments of proximal Tibia (Lippincott Williams & Wilkins Atlas of Anatomy 1st edition)



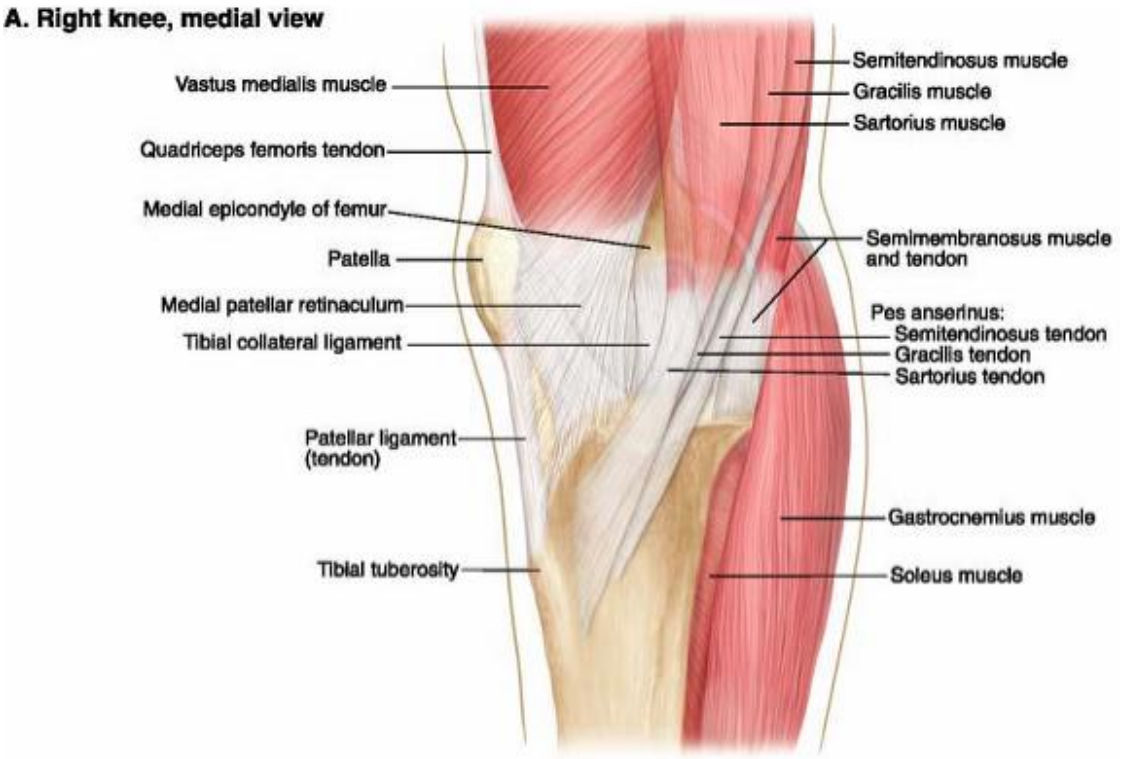


Fig 2 : Anterior and medial view of proximal Tibia (Lippincott Williams & Wilkins Atlas of Anatomy 1st edition)

Function of the Knee :

The knee is complemented with a selection of ligaments including the anterior and posterior cruciates, and the medial and lateral collateral ligaments. These serve to strengthen the knee structure as well as place restraints on the range of movements through which it can travel. Due to its location within the human skeleton, and the fact humans are bipeds, the knee joint is constantly exposed to varying forces which it must cushion and absorb to prevent the formation of pathological stresses. To cushion joint load, the articular surfaces are covered in cartilage, and the knee is equipped with the medial and lateral menisci which sit between the two articular surfaces of the femur and tibia[4].

Many muscles have insertions around the knee joint. Although some of these do not necessarily take part in gross knee movement, they play a crucial role in dynamic knee stability. The quadriceps muscle group sits above the patella and comprises the rectus femoris, vastus lateralis, intermedius and medialis. The quadriceps muscle group interacts with the patella via the patella ligament to extend the knee and maintain dynamic knee stability[4].

Joint Loadings during walking :

The loading in the knee joint is the largest of all joints. Repetitive and cyclic nature of walking associates it with Osteoarthritis knee (Andriachhi et al 2006; Jackson et al 2004).Mechanical overload causes micro damage in the subchondral bone leading to bone remodeling(Burr 2004). This remodeling increases the bone density, thereby decreasing its efficacy as a shock absorber. Thus, the joint cartilage suffers increasing dynamic stresses and it gets destroyed[5].

Biomechanical factors that influence joint loadings during walking are Anatomical alignment, Knee joint laxity and Dynamic stability[5].The varus moment during the stance phase has gained special interest. The knee varus moment is an external force caused by gravity trying to adduct the knee joint into a varus position(Fig 3). The varus moment during walking has been shown to be determinant for medial compartment compression(Schipplein et al. 1991) and has become a biochemical marker for risk of progression of medial compartment Osteoarthritis(Andriacchi et al. 2006). "Higher than normal" varus moments have been reported for severe Osteoarthritis of knee patients (Hurwitz et al. 2002) and it has been shown that increases in the varus

moment are associated with increased risks of loosening joint space (Miyazaki et al. 2002).

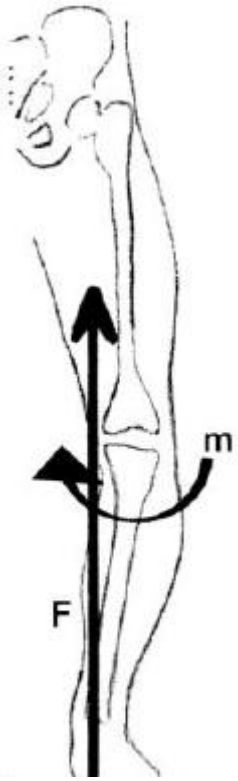


Fig 3 : The varus moment(m) is a moment tending to adduct the tibia with respect to the femur, causing increased medial compartment compression. The varus moment may be estimated by means of the ground reaction force vector (F) (Henriksen.M .The significance of pain in knee joint loading during walking, 2006).

KNEE OSTEOARTHRITIS :

Epidemiology :

Osteoarthritis (OA) of the knee is the most common form of joint disease and the prevalence of both radiographically evident and symptomatic knee OA has been reported to be higher and the prevalence with females is higher (Felson et al. 2005). The meta-analysis also reported that females tend to have more severe knee OA radiographically assessed than males and that the gender differences increase with age >55 years (Srikanth et al. 2005).

Of the three joint compartments, the medial compartment is the most common site of knee OA (Ledingham et al. 1993), presumably as a reflection of the distribution of loading with the majority of the load being placed on this compartment (Schipplein et al. 1991).

Aetiology & Pathogenesis :

The fundamental aetiology of knee OA is unknown, and it has been suggested that knee OA is the final common pathway in a group of overlapping disorders of diverse aetiologies, but with similar biological and clinical outcomes (Felson et al. 2000).

Pathogenetically, knee OA is characterized by structural changes in and around the knee joint. The predominant structural changes are the loss of cartilage and the formation of osteophytes. These changes are easily demonstrated radiographically, and objective measures of disease severity are based on the amount joint space loss (a reflection of cartilage loss) and the presence of osteophytes (Kellengren et al. 1957). Furthermore, the subchondral bone scleroses in the early phases of OA and this process, possibly involving microfracture, has been suggested to be pathogenetic factors in the process of cartilage degeneration (Burr et al 2003).

The predominant clinical feature of osteoarthritis knee is pain. Other clinical features are joint stiffness, swelling and deformation.The symptoms can be from mild to disabling.

Initial management may include Physical therapy, bracing, orthoses, ambulatory aids, nonsteroidal anti-inflammatory medications, glucosamine, chondroitin, intraarticular injections of steroid or hyaluronic acid and analgesics. Weight loss, change in daily, work and recreation al activities are advised. But as the disease is progressive, many require operative treatment. Some procedures are arthroscopic débridement, osteochondral or chondrocyte transplantation, high tibial osteotomy,

distal femoral osteotomy, arthroplasty, and arthrodesis. The choice of procedure depends on the patient's age and activity expectations, the severity of the disease, and the number of knee compartments involved[6].

Osteotomies Since 20th century :

Although osteotomies were performed regularly in the first half of the 20th century, the real breakthrough came only with the publication of Jackson, Waugh, Coventry, and others in the late 1950s and 60s. Osteotomy became a standard treatment option for unicompartmental osteoarthritis of the knee. Whereas Jackson operated distal to the tibial tuberosity, the classic osteotomy of Coventry was a closed-wedge osteotomy and was performed proximal to the tibial tuberosity. This was the most widely used technique for a long time. A medial opening wedge osteotomy with iliac crest bone graft and rigid fixation was described by Hernigou et al.

In the 1980s and 90s, osteotomy around the knee lost importance due to the success of knee arthroplasty. However, the development of new plates, particularly plates with angular stability, during the last ten years has led to a revival of osteotomy around the knee, especially for younger patients. With newer plates, the open wedge osteotomy became the favoured technique, being easier to perform, and is nowadays used

frequently with the advantage that it is more precise, quicker, has no risk of peroneal nerve injury and preserves the proximal tibia better when considering a future total knee arthroplasty.

PROXIMAL TIBIAL OSTEOTOMY :

High tibial osteotomy is an accepted procedure for treating unicompartmental osteoarthritis of the knee. Most reports have shown approximately 80% satisfactory results 5 years after osteotomy. Varus or valgus deformities are fairly common and cause an abnormal distribution of the weight bearing stresses within the joint. The most common deformity in osteoarthritic knee patients is a varus position, which causes stresses to be concentrated medially, accelerating degenerative changes in the medial part of the joint (Fig 4). In osteotomy the joint compartment which is involved is unloaded and the alignment corrected to distribute stress equally on the knee.

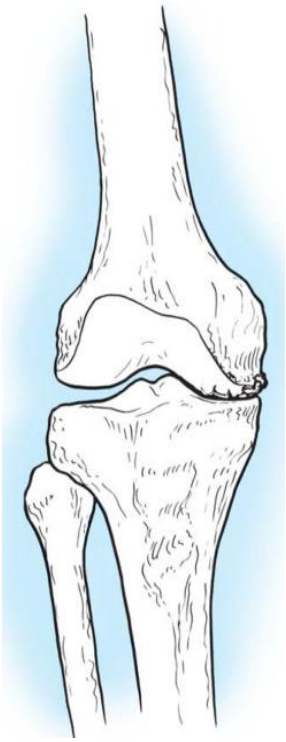


Fig 4 : In Osteoarthritis of knee, if the weight bearing concentrate stress in medial part of joint, varus deformity results. (Campbell 11th edition)

Some authors have reported arthroscopic evidence of fibrocartilaginous repair. Kanamiya et al. found that only three of the 58 knees showed no signs of repair, and 55% of patients had partial or complete coverage of eburnated lesions with fibrocartilage.

For valgus proximal tibial osteotomy, a number of procedures are described. Four basic types are most commonly used: medial opening wedge, lateral closing wedge, dome, and medial opening hemicallotasis.

A medial opening wedge osteotomy with iliac crest bone graft and rigid fixation was described by Hernigou et al.

Physiological or Mechanical axis of the leg :

The anatomical axis of the femur and tibia correspond to the diaphyseal midline of these long bones(Fig 5).

The mechanical axis of the femur runs from the center of the femoral head to the center of the knee joint .The mechanical axis of the leg (Mikulicz line) is the connecting line between the center of the femoral head and the center of the ankle joint (Fig 5). This line runs on an average 4 (± 2) mm medial to the center of the knee joint. If the mechanical axis runs lateral or medial to this point, this indicates either a valgus or a varus deformity.

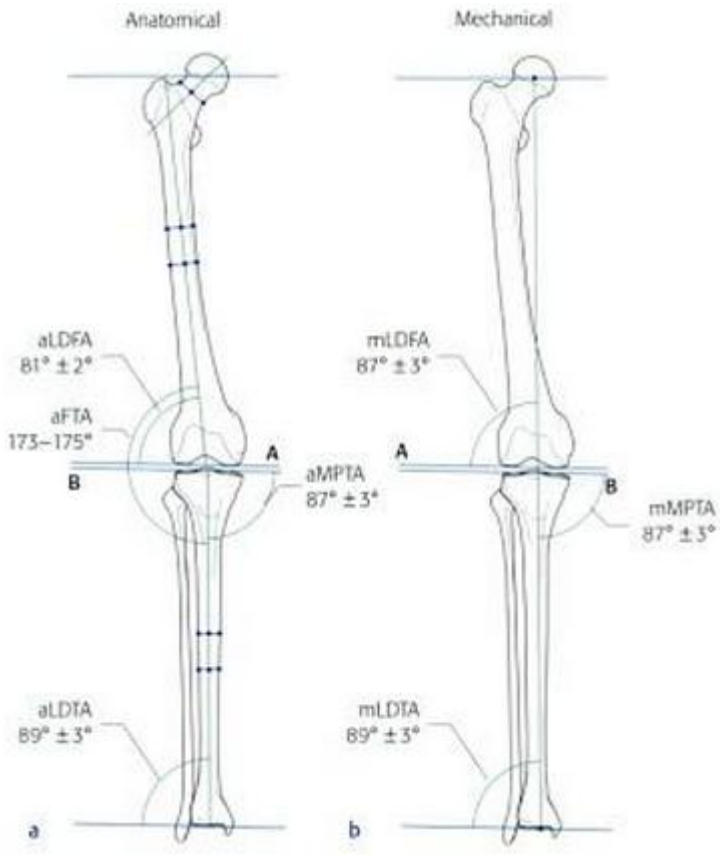


Fig 5 : Diagram of the leg axis and joint angles in the frontal plane (AO – Osteotomies around the knee)

Genu varum :

In genu varum the axis of femur and tibial diaphysis (aFTA) is marked and the lateral angle between them is calculated to be greater than 173˚ -175˚.The weight bearing line from the center of the femoral head to the midpoint of the upper ankle joint runs more than 4 (± 2) mm medial to the center of the knee joint, ie, in the case of a significant varus malalignment, the deviation of the mechanical axis (MAD) from the

center of the knee joint will be more than 15mm medially. The distance between the femoral condyles (intercondylar distance) is increased (Fig 6).

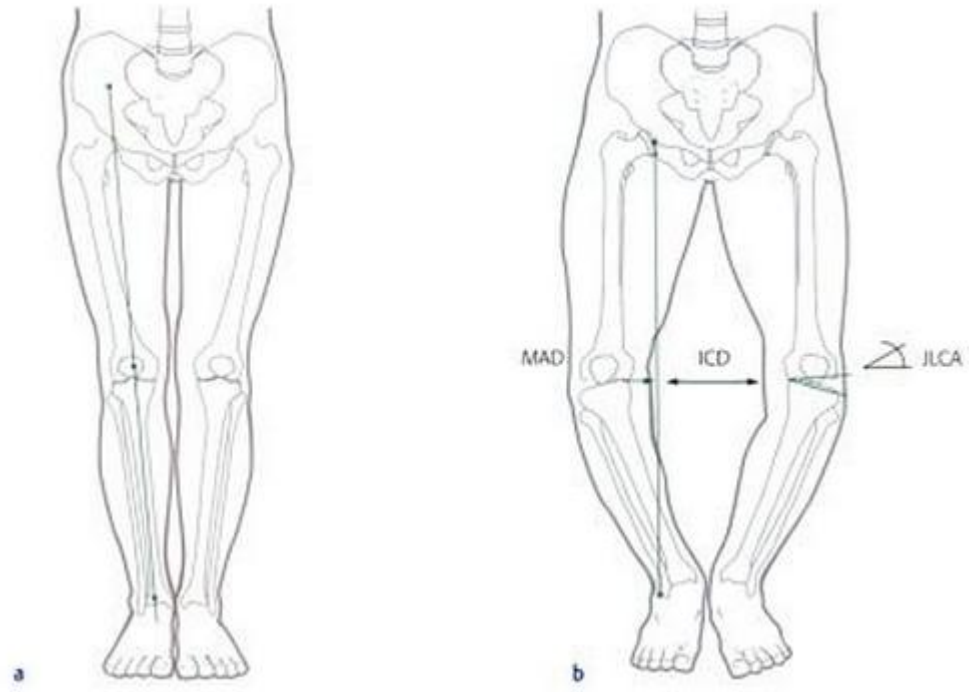


Fig 6 : Diagram showing normal lower limb(a) and varus deformity of the lower limb(b) (AO – Osteotomies around the knee)

Consequences of the lower limb deformities :

In the presence of tibial or femoral deviations in the frontal plane, forces can no longer be transferred uniformly at the knee joint. Instead, nonphysiological load distribution with mechanical stress occurs in the medial or lateral compartment. The mechanical overload of a joint

compartment correlates with cartilage damage and promotes the development of degenerative joint disease or accelerates its progress. Deformities of the lower extremity are regarded as so-called prearthritic deformities.

These osteotomies have a substantial effect on the load balance and the distribution of pressure at the knee joint. Open wedge and closed wedge osteotomies are established procedures for the restoration of the physiological axis and the treatment of varus and valgus to the knee joint.

Clinical Examination :

Patient history and clinical examination are the baseline of any preoperative work up for osteotomies around the knee. History of trauma or previous surgery, and professional activity and sports, are of special interest. The expected patient activity level is to be considered. Contraindications such as nicotine abuse, which often leads to delayed consolidation of the osteotomy, overweight, rheumatoid arthritis, and patient age over 60-70 years, where knee arthroplasty leads to better results, must be ruled out. Nevertheless, consideration of biological age should take priority over chronological age.

Clinical examination includes evaluation of soft tissue and skin as well as vascular and neurological status of the lower extremity. Systemic or local infection should be ruled out.

The range of motion of the knee should be at least 120˚ of flexion and not more than 20˚ extension deficit are mandatory. Anteroposterior and mediolateral ligamentous stability should be examined and the leg length must be inspected. The alignment of the lower extremity is evaluated under full weight bearing and in the supine position. If the medial compartment is involved, movement under varus stress is painful, whereas valgus stress should reduce pain.

Unicompartmental Osteoarthritis :

The most common group of patients presents with unicompartmental medial or lateral femorotibial osteoarthritis. These patients complain about pain in the affected joint compartment during weight bearing. If pain is not located exclusively either over the medial compartment or the lateral joint space, the indication for osteotomy should be reconsidered. Femoropatellar pain with significant degenerative changes of the cartilage is considered as a relative contraindication for osteotomy. Special attention should be addressed to the subjective pain level, for example wit h the visual analogue scale (VAS).

Radiographic views :

For preoperative assessment of the anatomy and the leg axis radiography of the knee joint in three planes (AP, lateral view, patella tangential view) and a weight-bearing x-ray of the entire lower limb are necessary. The weight-bearing x-ray of the leg is essential to assess the correct indication and for the planning of any osteotomy around the knee. The examination is performed in AP projection with a horizontally focused x-ray beam with the patient weight bearing on both legs. Malrotation must be avoided by aligning the patella to the front in the center of the femoral condyles.

Weight bearing x-rays with the knee in a flexion of 45˚ (so called 'Rosenberg view') may give information about the degree of changes and the joint collapse, respectively the joint-space narrowing of the affected compartment, but are not absolutely necessary.

Stage of Osteoarthritis :

An osteotomy is a biological procedure which aims to shift peak load areas from the medial compartment to central and lateral areas. The best results are obtained in limited chondral defects on the medial side and the outcome will be compromised the more the osteoathritis has progressed. The patient should be informed that limited pain relief must

be expected if there is already 4th degree osteoarthritis on the medial side with relative medial instability. It is very difficult to choose the correction angle in thos situation, and failures by under or overcorrection are common. Unicompartmental knee replacement is advisable in this situation. Obviously HTO is not indicated after substantial lateral meniscectomy and in severe lateral osteoarthritis. MRI scans should not be relied upon in decision-making, since the sensitivity and specificity for chondral defects are low. Arthroscopy tends to overestimate chondral pathology on the lateral side.

Patellofemoral joint :

Many patients with medial joint pain have degenerative changes in the patellofemoral joint as well. If the clinical symptoms are clearly those of medial osteoarthritis, these changes can be ignored in the decision-making process and should not guide the surgeon towards a TKA. Certainly the patient has to be informed that stair climbing or downhill walking may be compromised after the procedure but the leading symptoms of joint-line pain will be cured, as in patients without patello-femoral joint pathology.

Obesity :

The discussion on the importance of body weight on the development of osteoarthritis and on the outcome of orthopaedic procedures is never ending. Generally speaking, the obese patient loads his knee joint more, however, on a lower activity level. There is no clear correlation between body weight and results either for HTO or for unicondylar or total knee prosthesis, except for extreme obesity. In the new generation of plate fixators the mechanical stability and load-bearing tolerance is sufficient enough to abandon patient weight as a risk factor for fixation. No patient should be excluded from these procedures only due to overweight. In contrast, the implantation of a total knee prosthesis often requires an extended approach in these patients and is a significant surgical stress with increased risk.

Age :

Age limit for an osteotomy in males is 65 years and in females even may be as low as 55 years. The impaired results may be explained by the general progression of osteoarthritis, leading to a disease of the entire knee in many individuals and restricting tolerance of the joint to increased loads on the lateral side. However, in Asia, due to ethical and cultural factors, osteotomies are commonly performed in higher age

groups, and these are often successful. These age values are arbitrary and strongly depend on the individual patient.

Activity :

HTO is the procedure which allows for the highest postoperative activity level of a patient with monocompartmental osteoarthritis. However, the patient must be informed that he may not be completely pain free during strenous activity.

Range of motion :

If more than 10˚ of extension deficit is present, the indication for HTO should be questioned. A flexion deficit is usually not in the foreground in this patient group and the range of motion for flexion will not decrease in consequence of a tibial osteotomy.

Basic Principles of Osteotomies :

After detailed examination of the patient, correct planning is essential for successful osteotomy. A variety of approaches can be used to achieve a good result.

Level of osteotomy :

The osteotomy should be performed at the apex of the deformity. This will result in an optimal correction. Performed an osteotomy at a different level will not restore the physiological axes but create a new deformity.

The metaphysis of a long bone is the region of best healing capacity. Bone healing is significantly decreased at the diaphyseal bone.

Open wedge osteotomies are generally easier and more precise to perform than closed-wedge osteotomies. Furthermore, the opening procedure allows for intraoperative “fine-tuning” by adjusting the opening with a spreader. In most cases bone grafting is unnecessary when angular stable implants are used.

Restoring or preserving the horizontal joint line (midjoint line) is mandatory for achieving a good result.

Fig 7 : Location of hinge for planning of varus correction in a left knee (AO – osteotomies around the knee)

Planning method by MINIACI :

Once the localisation and kind of osteotomy is defined the preoperative drawing can be done. This can be done either on the weight –bearing x-ray of the leg or at a digital work station. Several methods of planning an osteotomy are described in the literature. Based on a study by Fugisawa et al and the planning method described by Miniaci, the authors have developed a technique to define the correction angle.

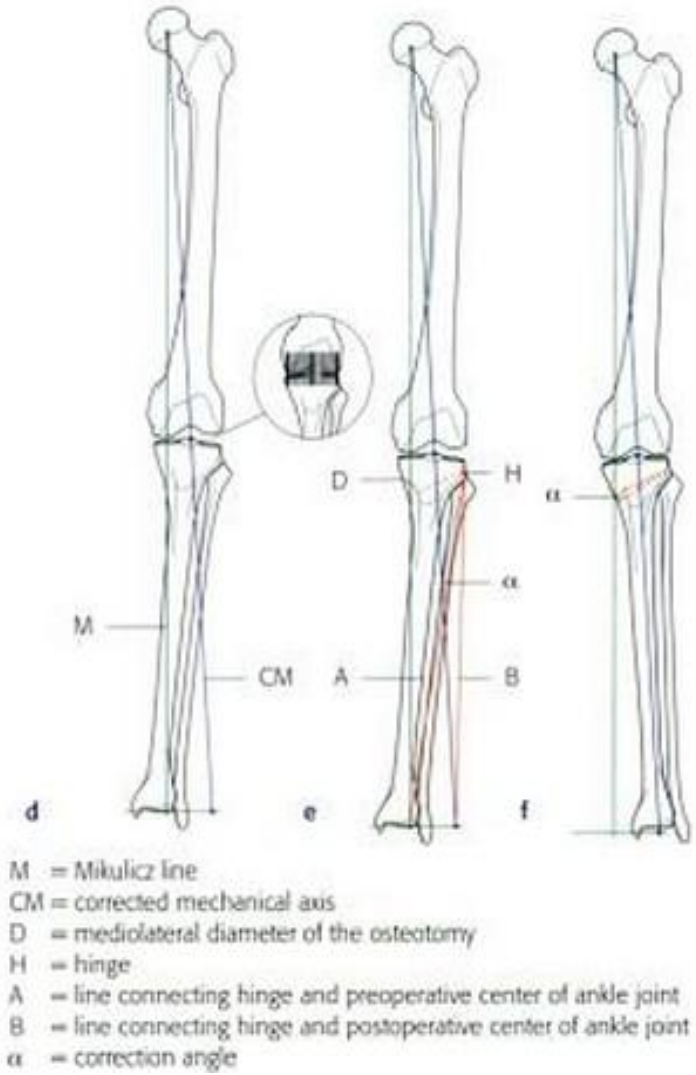


Fig 8 : Determination of correction angle (AO – Osteotomies around the knee)

Miniaci et al used the weight bearing line(WBL) to determine the correction angle. The first line is the WBL for correction extending from the center of the hip through 60-70% of the tibial plateau width past the ankle. The second line passes from the hinge point to the center of ankle

.The third line connects the osteotomy hinge point with the arc intersection of first one. The angle formed by second and third lines is the planned correction angle(x).

In closed-wedge osteotomies, the hinge point is located in the medial proximal tibial metaphysis, approximately 2.5 cm below the joint line. In open-wedge osteotomy, this hinge projects onto the lateral proximal metaphysis on the level of the proximal border of the tibiofibular joint, around 15 mm below the subchondral sclerosis zone of the lateral plateau. This angle (x) can now be drawn on the proximal tibia using the defined hinge point as tip of the triangle. In closed-wedge osteotomy, the two planes of the osteotomy are marked and the base of the triangle on the lateral cortex corresponds to the height of the wedge to be resected. In open-wedge osteotomy, the triangle should also be drawn and the base of the triangle on the medial cortex corresponds the opening of the osteotomy.

Fig 9 : Miniaci method (AO – Osteotomies around the knee)

HIGH TIBIAL OPENING WEDGE OSTEOTOMY :

Surgical Principles :

The principle of treating medial unicompartmental osteoarthritis with varus deformity by shifting the mechanical weight-bearing axis (Mikulicz line) laterally to relieve the medial compartment. High-tibial osteotomy may delay the need for arthroplasty in young and physically active patients. It is regarded as an established procedure for medial osteoarthritis, showing good results.

In contrast to the lateral closed-wedge method, the medial open-wedge technique offers certain advantages:

- Only one osteotomy is required

- Fibular osteotomy, dissection of the peroneal nerve, and detachment of the extensor muscles can be avoided

- No shortening of the lower extremity

- Future Total knee arthroplasty will be easier

Puddu plate :

Although a number of different fixation devices are available for osteotomies, the Puddu plate has a certain advantage more than earlier fixation devices but less than Tomofix fixators.

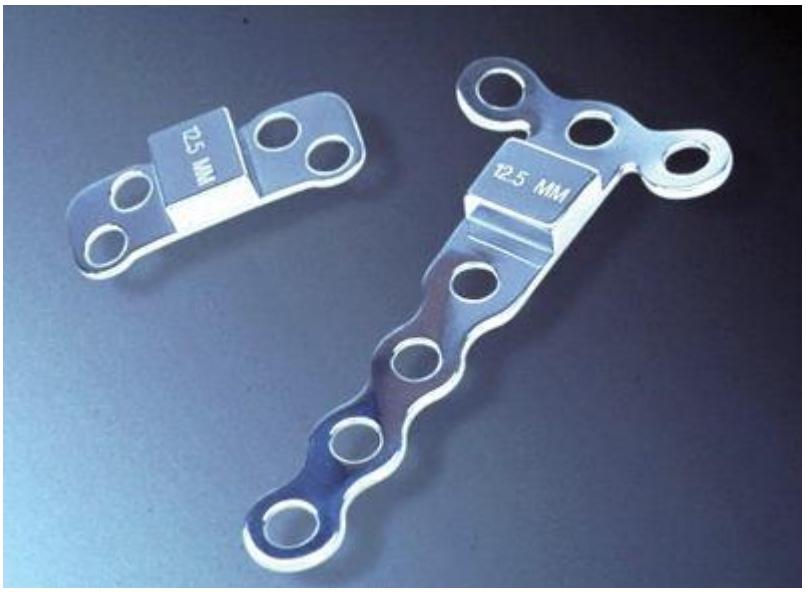


Fig 10 : Puddu plate

Giancarlo Puddu, who was an Italian Professor popularised the medial open wedge osteotomies with the Puddu plate in 1990s, which was named after him. Rather than filling the osteotomy gap with bone, it will be advantageous to place a spacer which can bear the weight. Professor Puddu had this idea and so he developed this plate with a spacer. This plate design was made in coalition with Arthex. There are two designs available for this plate(Fig 10).

The plate with a long stem is about 3 inches in length and about 1.25 inches in breadth. The spacer is of two dimensions in height. One is of 10 mm and the other is of 12 mm. The thickness of the spacer is about 5 mm(Fig 11).

The disadvantage of this plate is that it cannot be used for very large varus corrections.

Fig 11 : Puddu plate dimensions

Surgical Technique :

The operation begins with the knee in 90˚ flexion. The skin incision is made in the medial aspect of the proximal tibia. The infrapatellar branch of the saphenous nerve is preserved. The subcutaneous tissue dissectedand the pes tendons retracted. This exposes the medial collateral ligament, which is elevated from the tibia with a raspatorium. The long fibres of the superficial medial collateral ligament are then carefully detached until the posteromedial cortex of the proximal tibia is exposed. A Hohmann retractor is inserted behind the tibial ridge. At the anterior edge of the incision, the insertion of the patellar tendon at

the tibial tuberosity and the medial border of the patellar ligament are exposed. The cranial border of the patellar tendon insertion must be clearly visualised so that the destination of the ascending osteotomy can be defined later in the procedure.

The leg is now positioned in full extension and the knee joint adjusted in exact AP view under fluoroscopy. The medial and lateral compartments must be fully aligned in AP projection, and the leg should be held exactly anterior. While this position is maintained, two 2 mm k-wires are drilled into the tibial head under image intensification to mark the direction of the osteotomy. Both wires should run parallel and aim towards the upper third of the proximal tibiofibular joint.

When placing the two wires, it is important to ensure that there is sufficient space cranial to the saw cut for the three locking bolts in the T-arm and the first proximal screw in the longitudinal shaft of the plate. First, the posterior wire is inserted at the cranial border of the pes anserinus just in front of the posterior tibial ridge. The second wire is placed about 2 cm anterior and parallel to the first wire. Since both wires end at the lateral tibial cortex, the width of the tibial head can now be measured with reference to the two inserted wires. This is done by holding a third wire of the same length onto the cortex and measuring the

excess length compared to the inserted wires. The tibial diameter is generally 5-10 mm smaller anteriorly than posteriorly. The measured values should be noted. The depth of the saw cut is 10 mm less than the value measured against the wires in order to leave a lateral bone hinge.

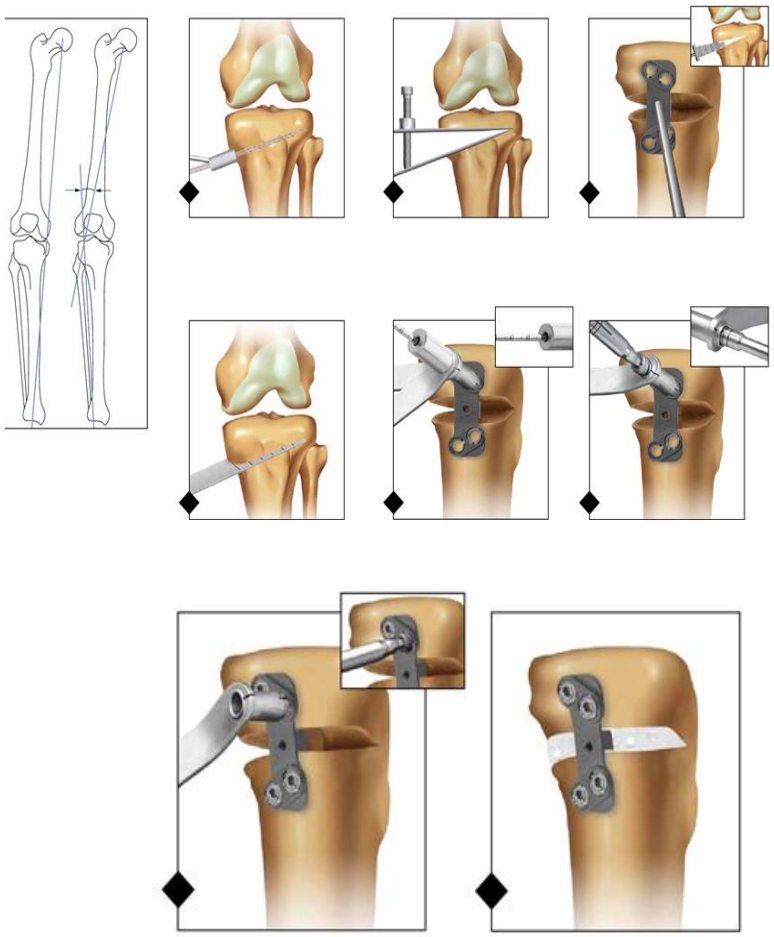


Fig 12 : Steps involved in medial open wedge osteotomy

The knee is positioned in 90˚ flexion again. Electrocautery is used to mark the course which runs at an angle of 110˚ to the horizontal saw cut ending behind the pateller tendon insertion. This tuberosity segment should be at least 15-20 mm wide.

The horizontal osteotomy is performed with the oscillating saw below the two guide wires that act as guide rails. Attention must be paid to complete the osteotomy of the hard posteromedial tibial cortex. The anatomical structures dorsal of the posterior tibial surface tibia are protected by a Hohmann retractor. The entire sawing procedure is performed is performed slowly, with very little pressure, and under constant cooling of the saw blade by irrigation.

The osteotomy should be opened slowly over a period of several minutes in order to prevent fracturing of the lateral cortex. Leaving the two guide wires in place while opening the gap leads to stiffening of the proximal segment and prevents fracture of the articular surface of the tibia.

When the planned width has been achieved, an arthrodesis spreader is placed in the posteromedial corner of the osteotomy.

Due to the medial collateral ligament complex the osteotomy tends to open more anteriorly during spreaing, thus increasing the caudal

inclination of the tibial plateau. Therefore, it is important to ensure sufficient release of the long superficial fibres of the ligament and symmetrical opening of horizontal osteotomy.

After spreading of the osteotomy gap to the desired width, the leg is again placed in extension. In this position, the leg axis can be evaluated clinically and radiologically.

It is not necessary to fill the gap with bone substitute. Suction drainage is not necessary.

Errors, hazards and complications :

- Over and undercorrection of the mechanical axis as a result of inadequate preoperative planning and insufficient intraoperative assessment of the axis.

- Damage to the bone surface due to excessive pressure and heat during sawing.

- Hematoma

- Postoperative soft-tissue swelling and lymph edema

- Deep crural thrombosis and /or pulmonary embolism

- Compartment syndrome

- Superficial and deep infections

- Delayed consolidation of the osteotomy gap.

Effects of Osteotomy :

The degenerated medial compartment cartilage is thus decompressed resulting in a relief of pain and a delay of cartilage damage. This helps the patient to walk without pain and thereby increase their functional outcome of the knee joint.

Bone Healing :

The author's experience indicates that bone healing in the osteotomy gap progresses from lateral to medial. A lateral bone bridge is left intact intraoperatively, ie, the so called hinge, which is defined at about 10% of the bone width. This hinge is not cut during osteotomy and yields to plastic deformation when the osteotomy gap is opened. A distance of 5-10 mm to the lateral cortex to be optimal.

An early sign of bone regeneration is an increase in bone density at the osteotomy surfaces. Band shaped zones of new bone at the osteotomy

surfacesas part of the healing process. In this way, the osteotomy gap is successively consolidated from lateral to medial. After 6 weeks bone contact is seen in almost one-third of the osteotomy surface at the interface between the tibial head and the tibial shaft. There is very rapid consolidation often already after 3 weeks.

MATERIALS AND METHODS

This is a prospective study of patients who attended the orthopaedic out pateint clinic in our hospital between September 2010 to October 2012. The patients were evaluated by clinical examination and weight bearing radiographs. The patients who were found to have unicompartmental osteoarthritis with knee pain not relieved by conservative management and who satisfy the inclusion criteria were selected.

INDICATIONS :

1. Pain and disability resulting from osteoarthritis that interfere with high-demand employment or recreation.
2. Evidence on weight bearing radiographs of degenerative arthritis that is confined to one compartment with a corresponding varus deformity.
3. The ability of the patient to use crutches after the operation and the possession of sufficient muscle strength and motivation to carry out a suitable rehabilitation program.
4. Good vascular status without serious arterial insufficiency or large varicosities.
5. Age < 60 years.

CONTRAINDICATIONS :

1. Narrowing of lateral compartment cartilage space.
2. Lateral tibial subluxation of more than 1 cm.
3. Medial compartment tibial bone loss of more than 2 or 3mm
4. Flexion contracture of more than 15 degrees.
5. Knee flexion of less than 90 degrees.
6. More than 20 degrees of correction needed.
7. Rheumatoid arthritis.

The patients were explained about osteotomy and its advantages and disadvantages were discussed. Those patients who were willing for the procedure were selected and their consent obtained.

Pre-operative planning is done by Miniaci method and pre-operative evaluation by Visual Analogue pain scale, Knee society knee scale and Japanese Orthopaedic Association Knee rating scale (See Appendix).

High tibial opening wedge osteotomy is done using Puddu plate (10 mm or 12 mm) according to the desired wedge to be created. The surgical steps are as described before. Bone grafting was done in one patient and in all other eleven patients, bone grafting was not done.

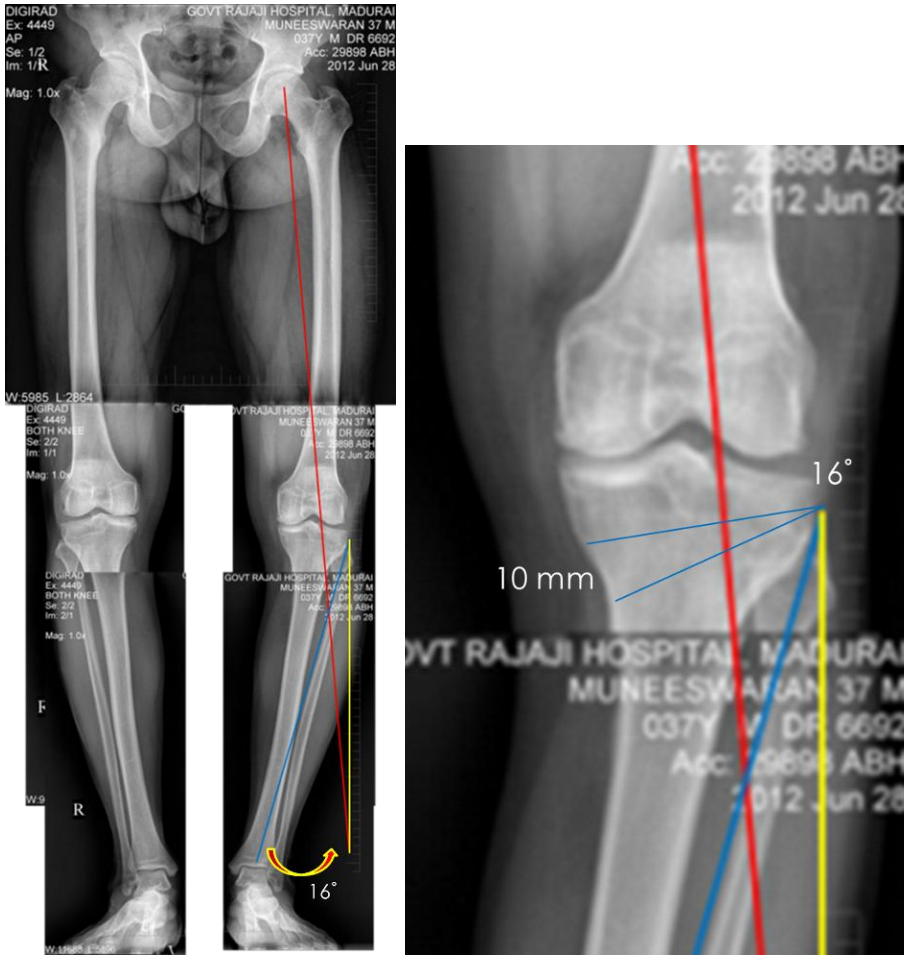
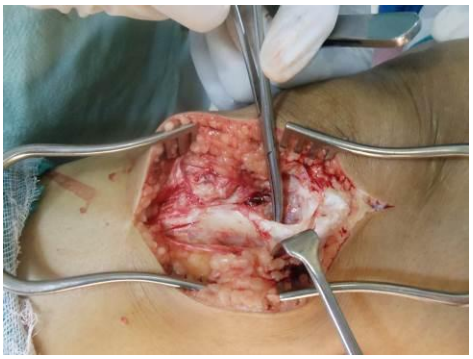


Fig 13 : Miniaci method of calculating correction angle in weight bearing xrays.

Surgical Technique :

Skin Incision

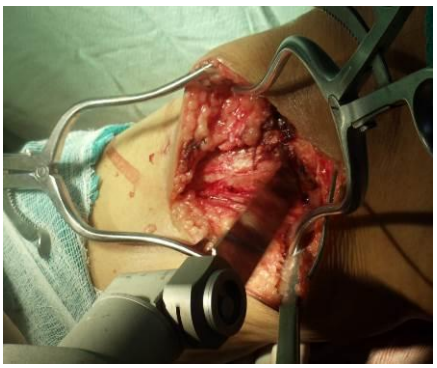
Soft tissue dissection



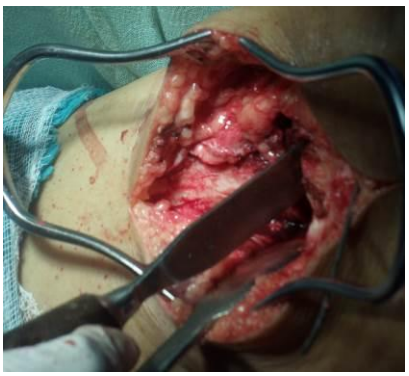
K- wires placed

Checked by Radiography

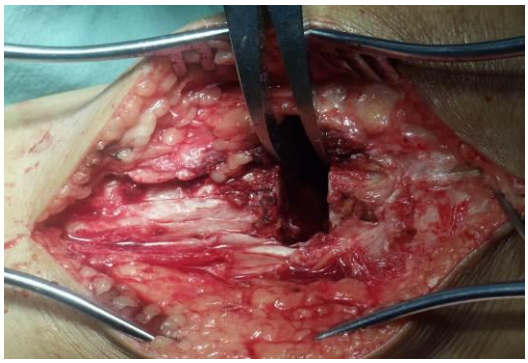
Initial cut using saw



Osteotome to break further

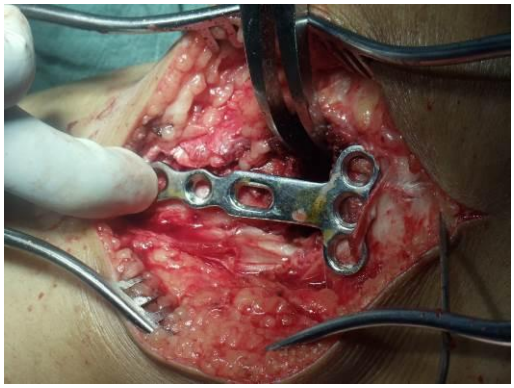


Wedge opened up

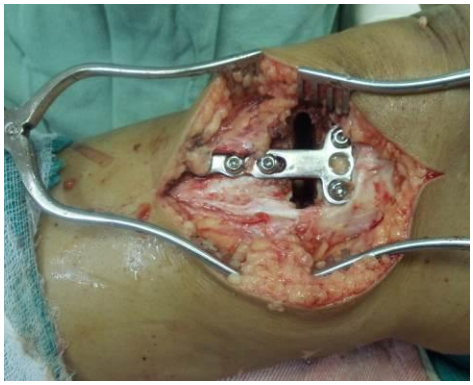


Puddu plate contoured

Plate placed in wedge



Screw fixation done



Positioned and Wedge checked Radiographically

Post-operative protocol :

Post-operative protocol for the patients is

1. Immobilisation in a tube slab till end of 3 weeks.

2. Knee brace is applied and the patient is encouraged to do partial weight bearing using crutches or walker till the end of 7 weeks.

3. The patient is then allowed to weight bear completely.

4. The patient is advised to refrain from high demanding activities till signs of complete bone union in wedge is evident.

The patients are evaluated at 3, 6, 12, 18, 24 months by radiographs, pain scale and knee scales (See Appendix).

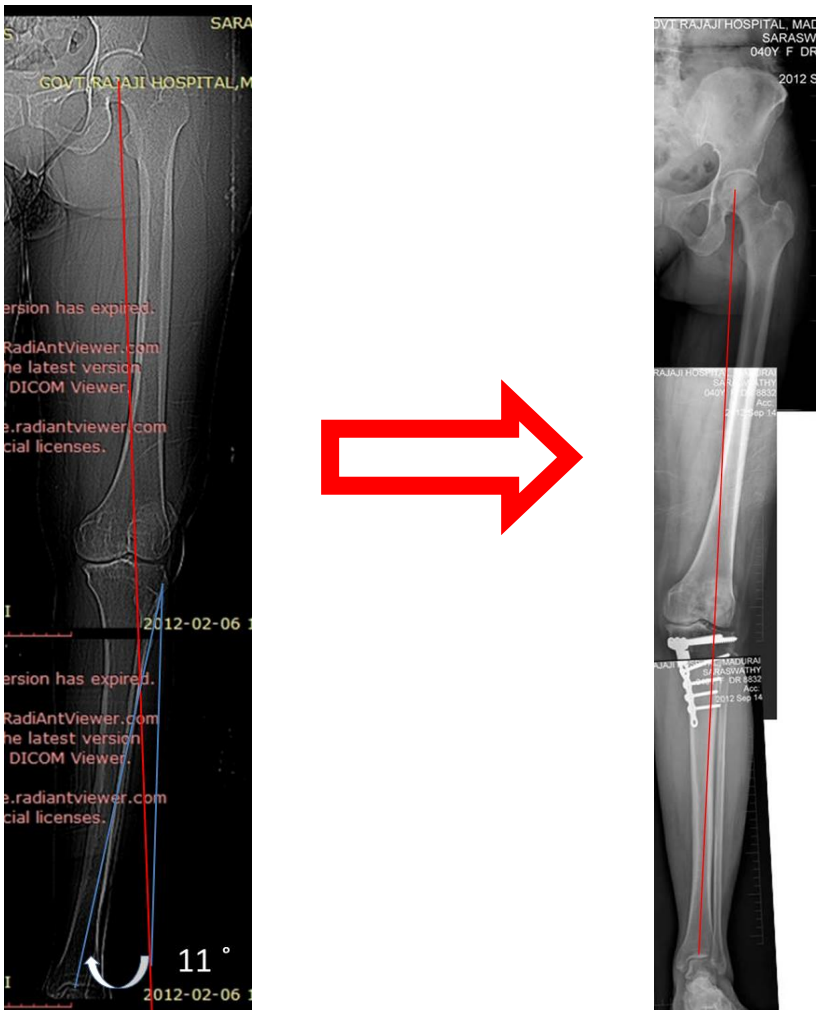


Fig 14 : Weight bearing Lowerlimb Pre-operative and Post-operative radiographs of a patient who underwent high tibial osteotomy. using puddu plate depicting the correction of Mechanical axis of the lower limb.

OBSERVATION

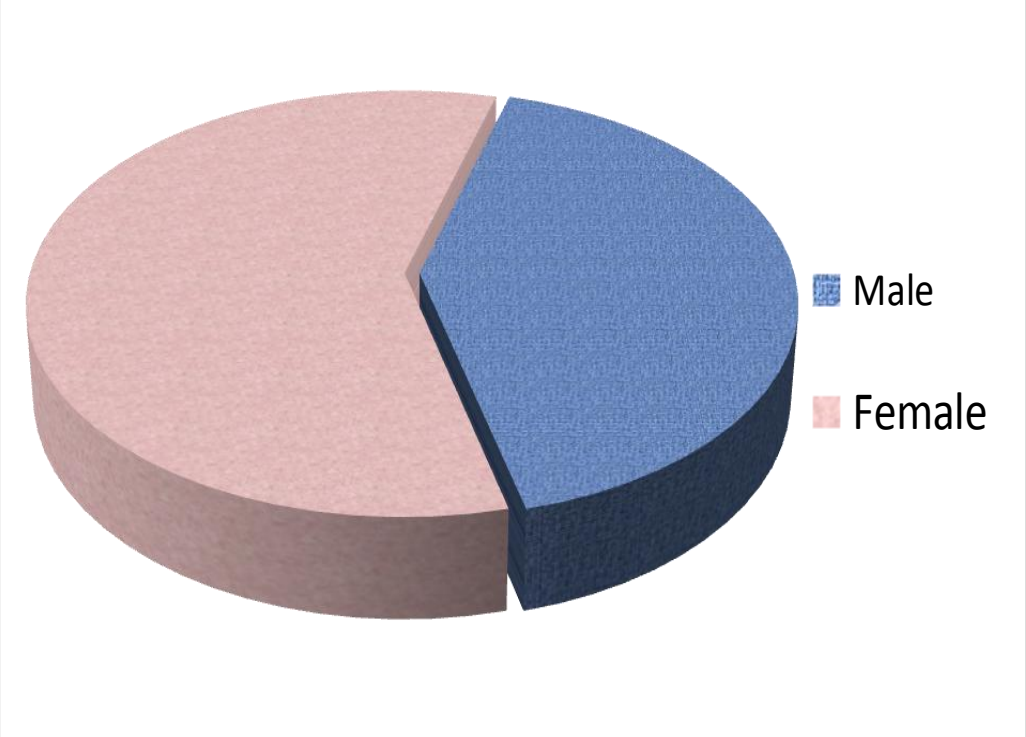
Opening wedge osteotomy using puddu plate was performed in Thirteen knees of Twelve patients with minimum age of 35 and maximum age of 54 and the average age is 41.8 years. All the patients were followed up between 6 months and 28 months and the mean followup is 18.6 months.

Patients were analysed for any complications and their functional outcome was compared with their previous status.

The patients were evaluated objectively by weight bearing radiographs and subjectively by visual analogue pain scale, Japanese Orthopaedic association knee rating scale and knee society knee score.

Gender :

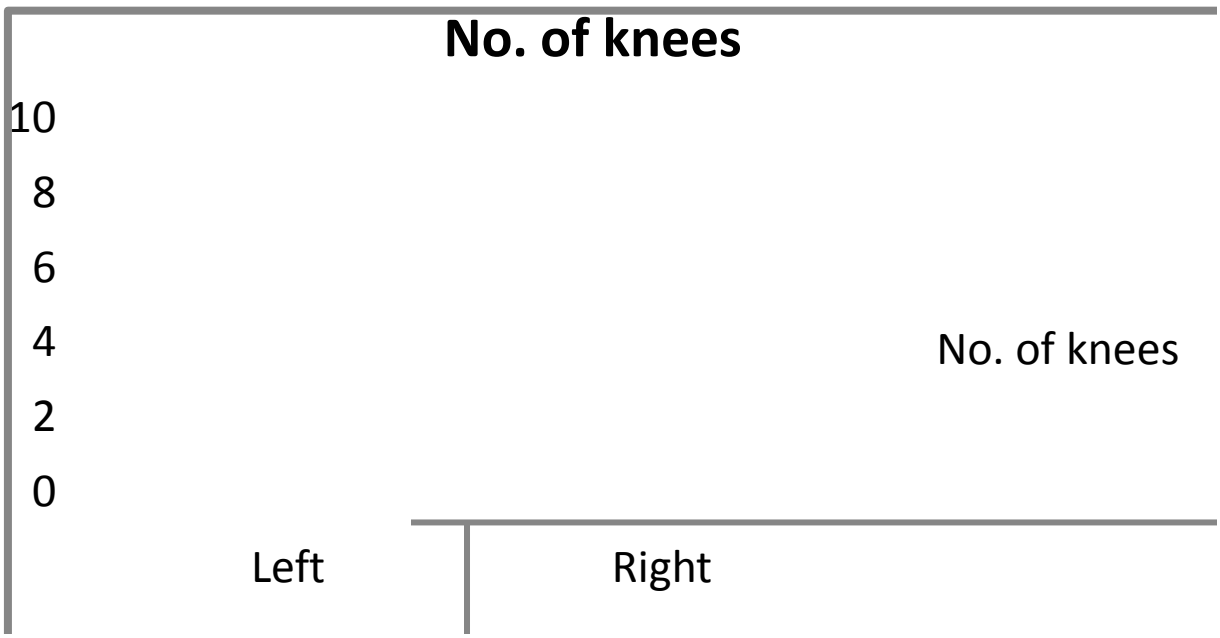
Of the 12 patients there were 5 male and 7 female patients



GENDER	NO. OF PATIENTS
MALE	5
FEMALE	7

Side of Involvement :

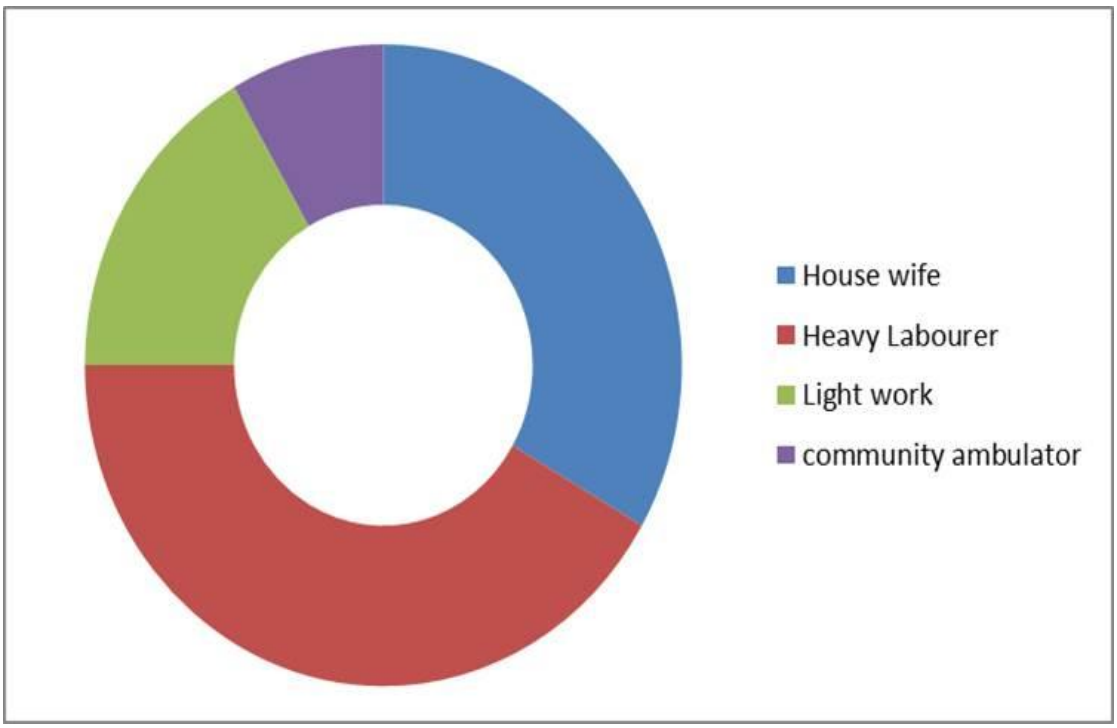
Of the thirteen knees operated, 9 were of left side and 4 of right side.



Occupation :

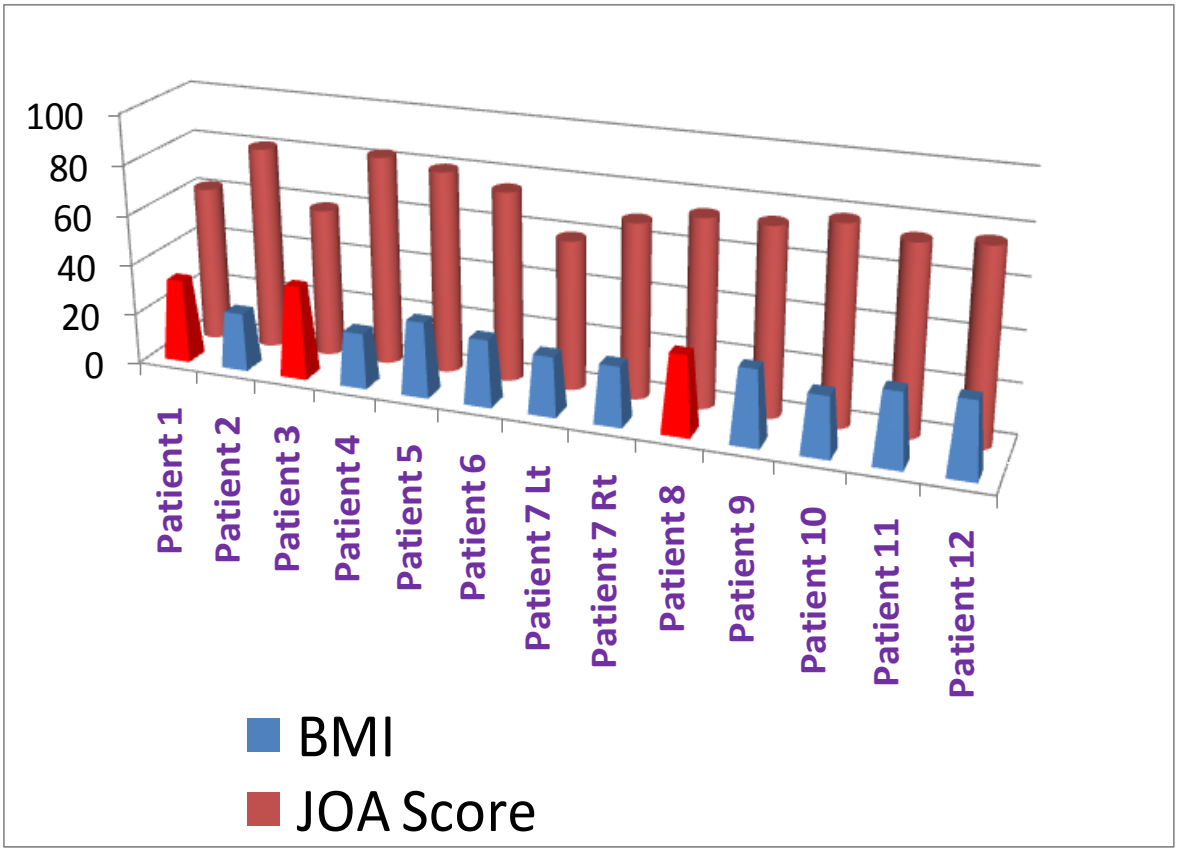
Of the 12 patients

Manual Labourer	:	5
House wife	:	4
Light work	:	2
Community ambulator	:	1



Relation between BMI and outcome :

The minimum BMI (Body Mass Index) was 21.5 and the maximum 36.5. One patient was Severely obese, two patients were were Moderately obese, five patients were overweight and four patients had normal weight. The average BMI was 27.8.



The three patients in the obese category were marked in red in the above figure. Of the three patients, one severly obese had poor outcome, other one had fair and the third person had excellent outcomes.

Complications :

Two patients had superficial infection and one patient had hardware prominence causing pain and one patient had under correction of varus.

The patients with infection were treated with appropriate antibiotics and regular dressings. They were followed up closely and their implants were removed after 6 months. Subsequently they were followed up. One patient had hardware prominence causing anterior leg pain and the implant was removed in her after 6 months. One patient had under correction of varus but he is followed up closely as he was not willing for another correction.

Superficial Infection over the incision site

Case : 1

Pre op

Post op

After plate removal

Case : 2

Pre op | Post op | After plate removal

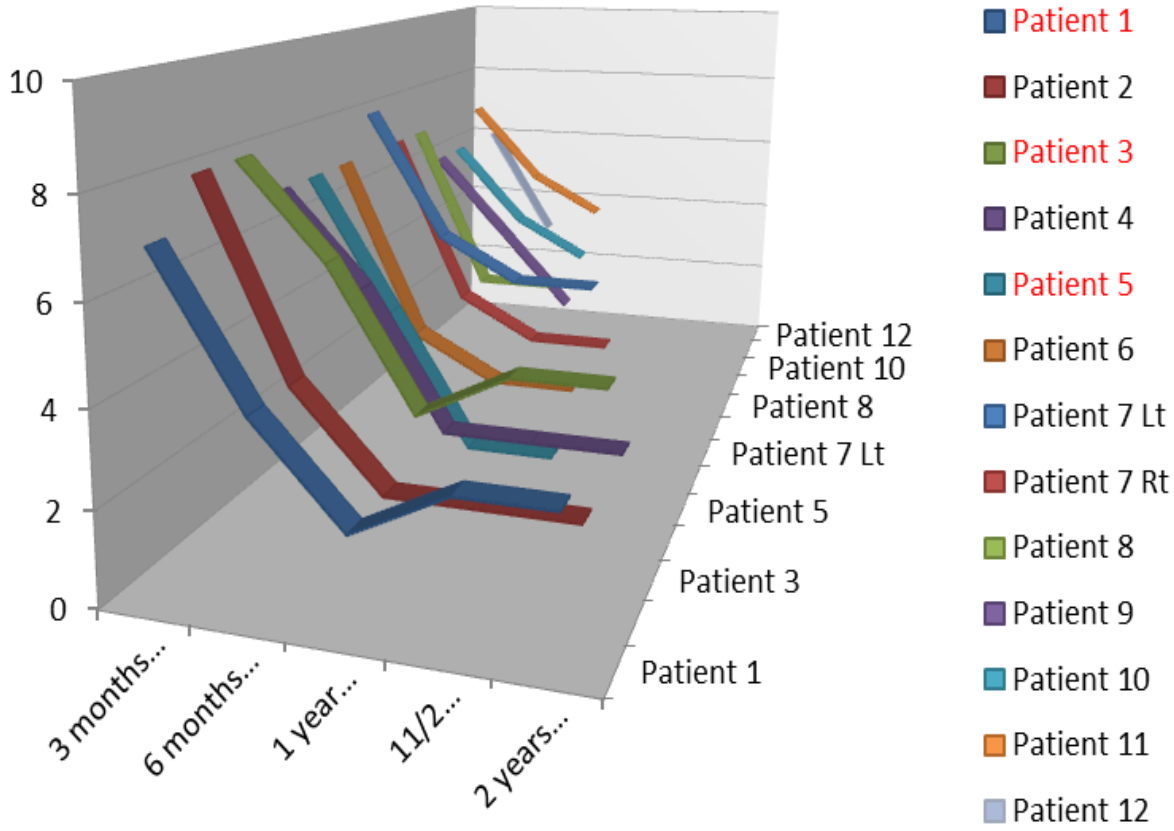
Patient with Hardware prominence

Pre op

Post op

After plate removal

Visual Analogue Pain Scale :



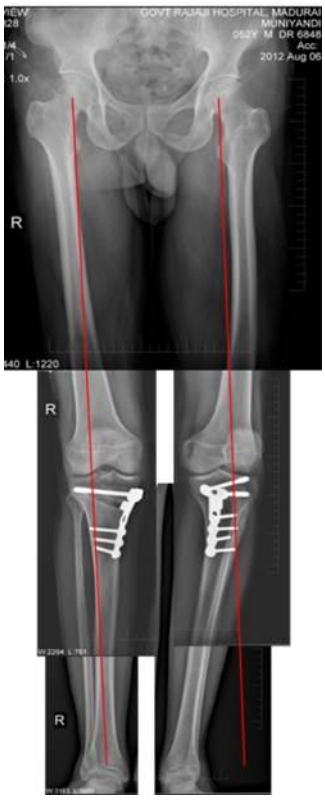
The names of the patients with complications are marked in red colour. These patients had fair pain relief and all other patients had good relief. It is to be noted that the patients had maximum pain relief only after 1 year which could be correlated to the time for cartilage regeneration.

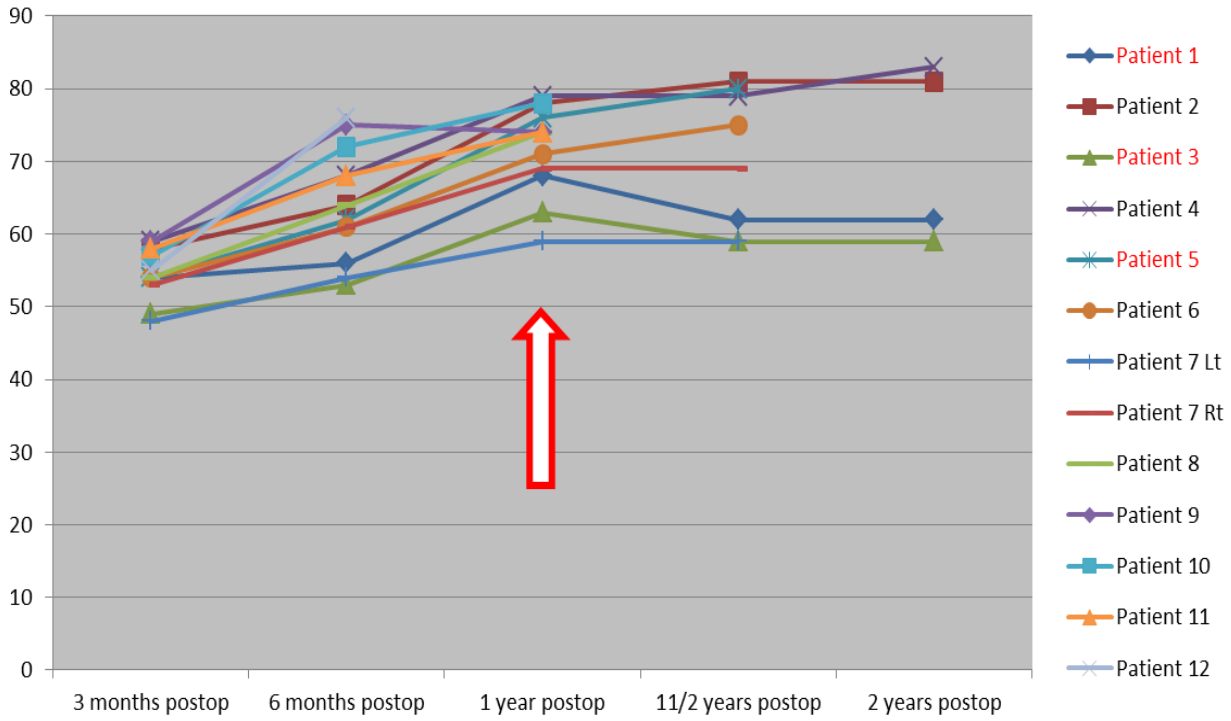
Japanese Orthopaedic Association Knee rating Scale :

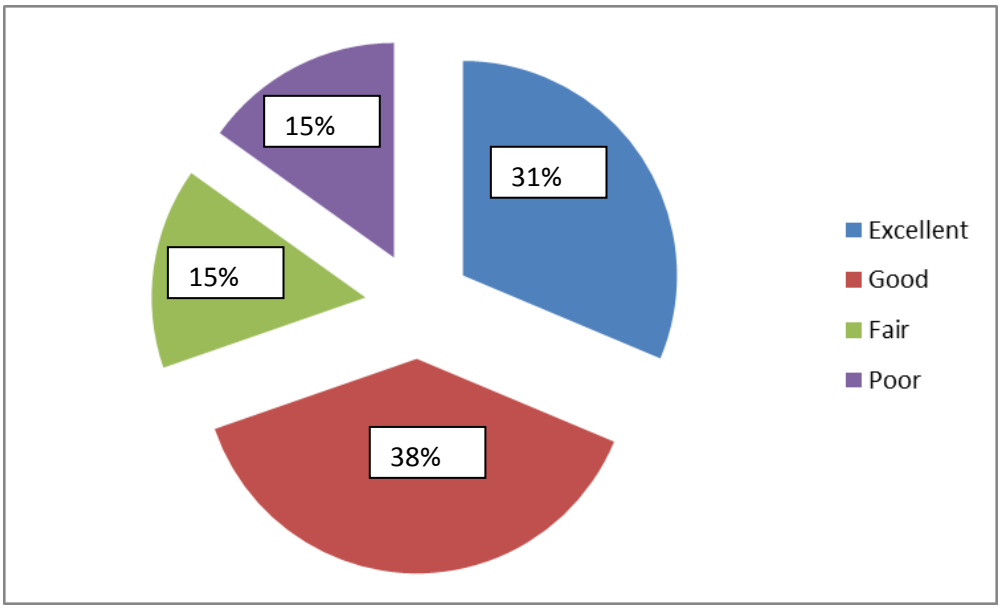
Of the 13 knees operated, 4 had excellent outcome, 5 had good outcome, 2 had fair and 2 had poor outcome.

The poor result of one patient is correlated to superficial infection and the other patient due to inadequate correction. Also to be noted is the scoring improved upto 1 year and thereafter it remained a plateau.

Inadequate varus correction in the left knee

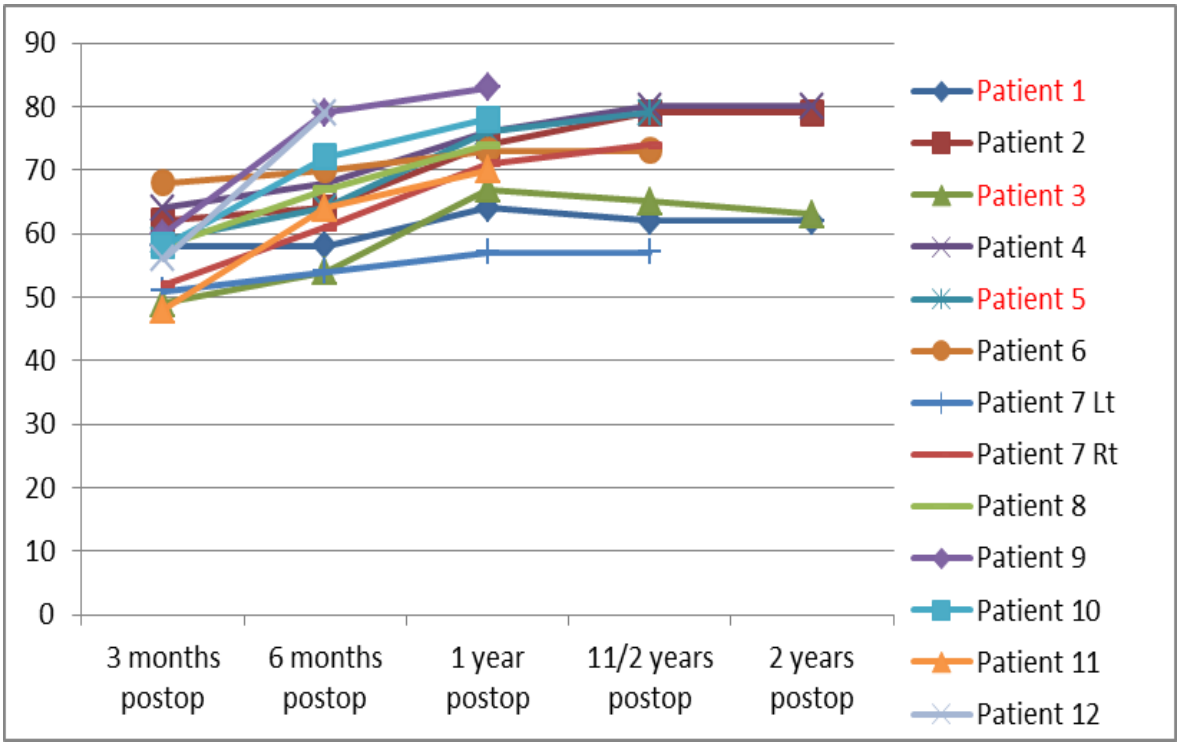


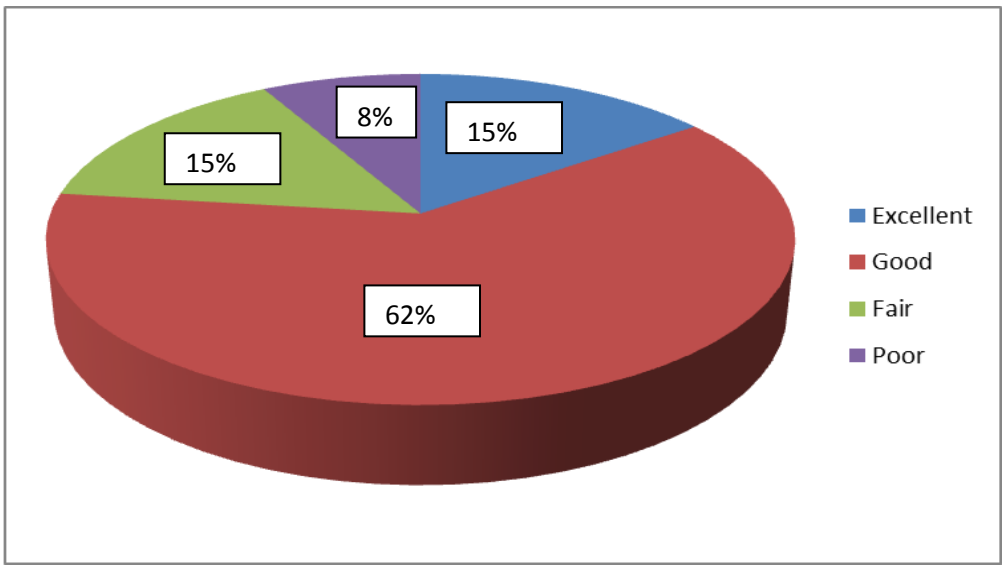

90
80
70
60
50
40
30
20
10
0
3 months postop
6 months postop
1 year postop
11/2 years postop
2 years postop
Patient 1
Patient 2
Patient 3
Patient 4
Patient 5
Patient 6
Patient 7 Lt
Patient 7 Rt
Patient 8
Patient 9
Patient 10
Patient 11
Patient 12


15%
31%
15%
38%
Excellent
Good
Fair
Poor

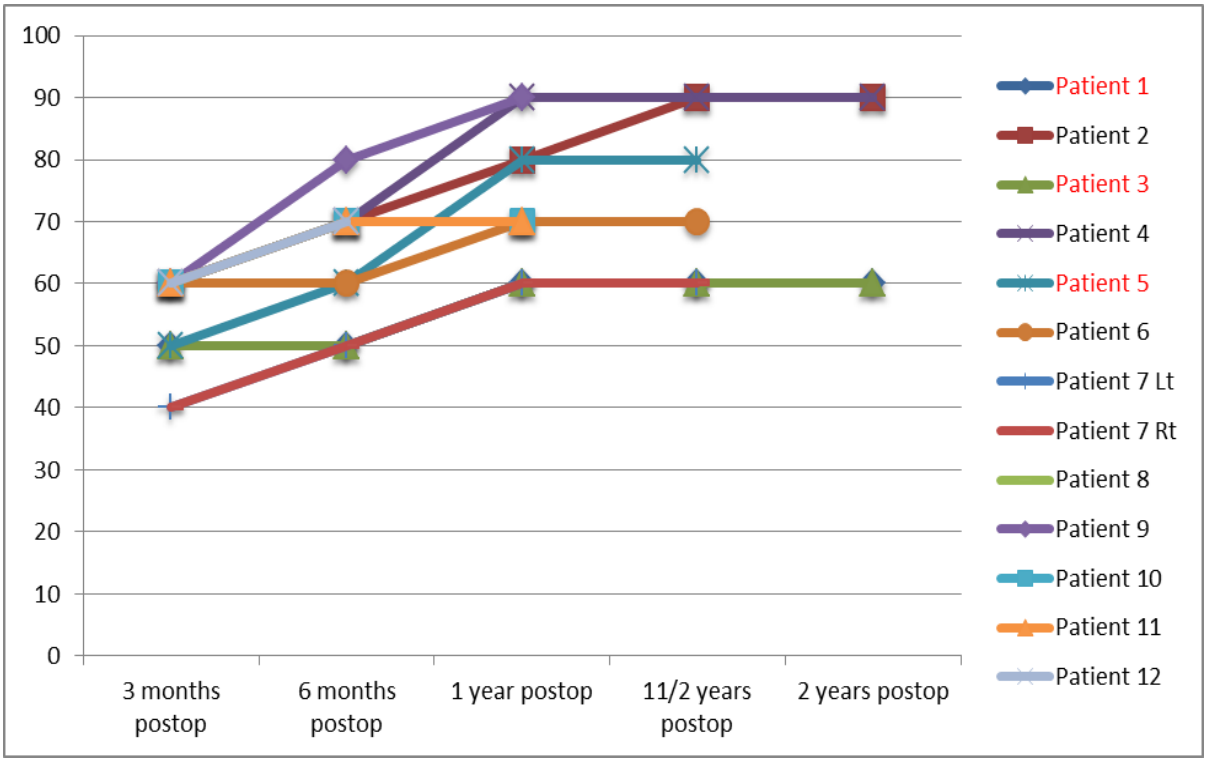
‘Knee Society’ Knee scoring system :

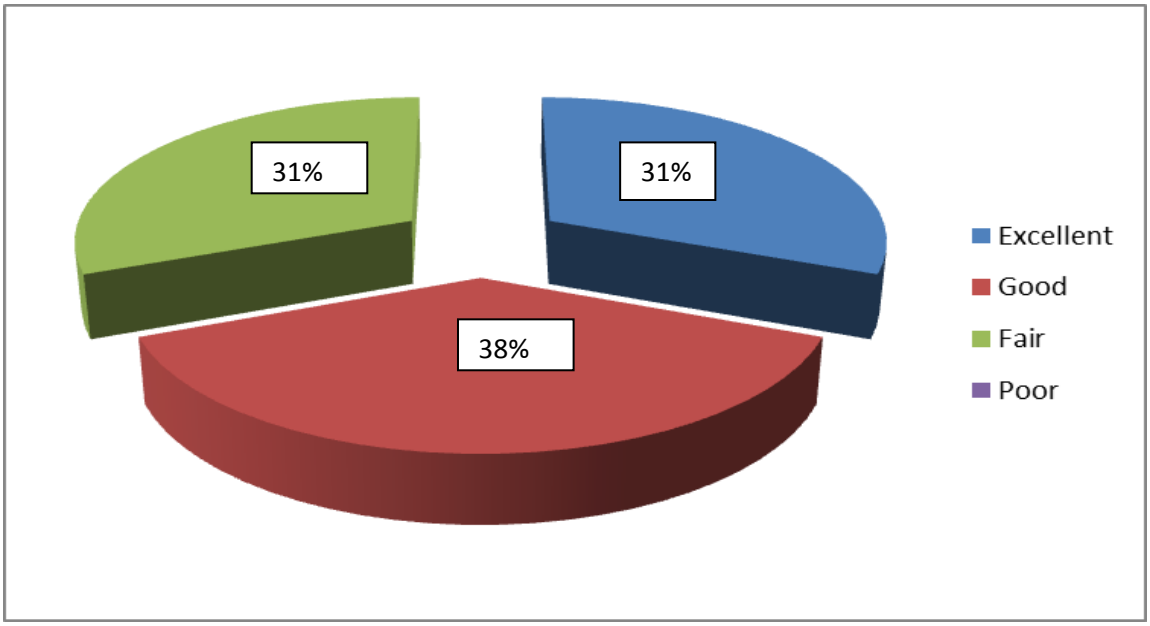
Knee Score





Function Score





The knee scores were excellent in 2 knees(15%), good in 7 knees(62%), fair in 2 knees(15%) and poor in 1 knee(8%).

The function scores were excellent in 4 knees(31%), good in 5 knees(38%), fair in 4 knees(31%) and no poor outcome.

Bone grafting :

Bone grafting was done in one patient only. All other 12 knees were not grafted.

Patient in whom grafting was done

Patient in whom bone grafting was not done

Immediate post op

6 months

12 months

20 months

In all the knees the early signs of bone consolidation starts by 3 months and by 1 year they cover most of the wedge and consolidation was evident.

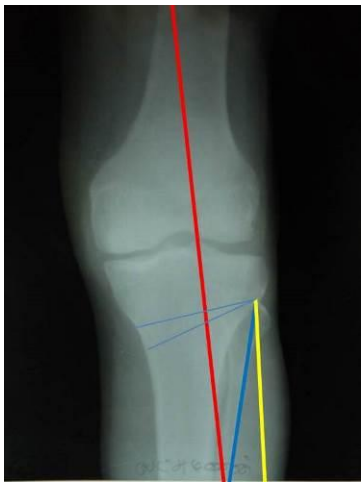
ILLUSTRATIVE CASES

Case : 1

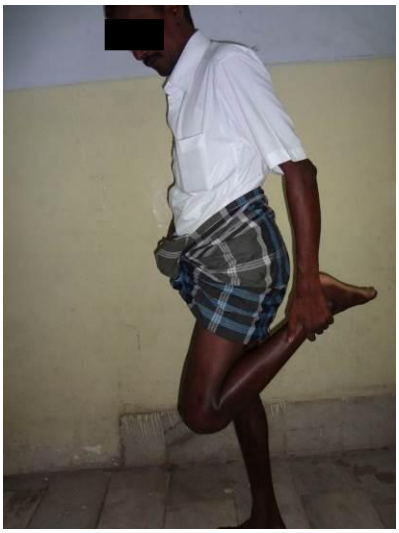
- 37/M
- Lorry Driver by occupation
- Knee pain for 2 yrs
- Correction required 12˚
- BMI - 21.5

	Pain scale	Knee Society score	JOA knee rating scale
Pre-operative	7	64 60	59
Post-operative	2	80 90	83

Pre – operative



Post-Operative - 3 months



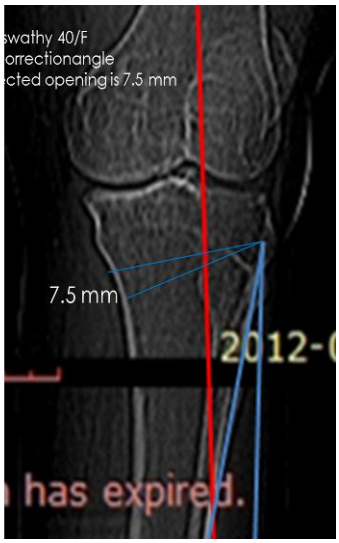
Post- Operative – 2 years

Case : 2

- 40/F
- Pain in Lt knee – 3 yrs
- Correction required – 11˚
- BMI - 26.0
- House maid

	Pain scale	Knee Society score	JOA knee rating scale
Pre-operative	7	68 60	54
Post-operative	2	73 70	75

Pre-Operative



Per -Operative

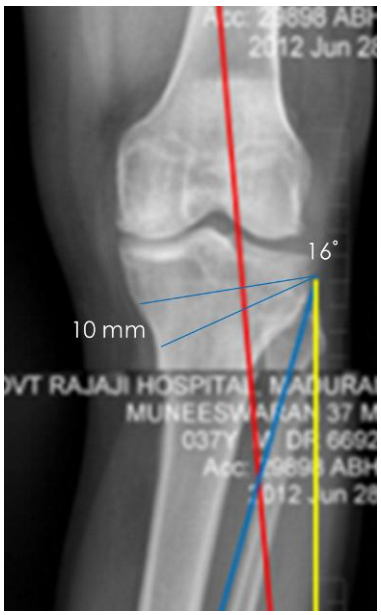
Post-Operative - 18 months

Case : 3

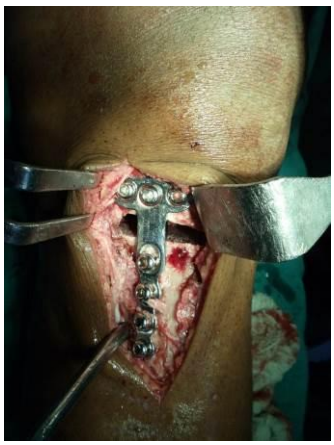
- 47/M
- Pain in Lt knee – 5 yrs
- Correction required – 16˚
- BMI - 29.4
- Supervisor

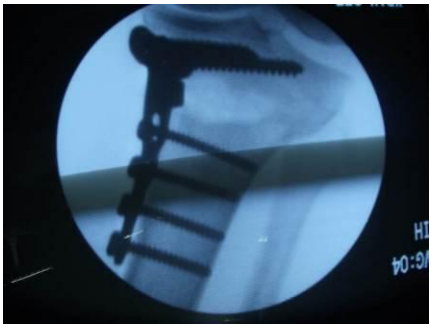
	Pain scale	Knee Society score	JOA knee rating scale
Pre-operative	6	60 60	59
Post-operative	2	86 90	80

Pre-Operative



Per-Operative





Post-Operative – 18 months

RESULTS

Total No. of Knees	13
Women %	58
Left Knee %	69
Mean Age in Years	41.8 yrs
Mean Body Mass Index	27.8 (over wt)

Average values	Pain scale	Knee society score	JOA knee rating scale	Mean Walking Distance
Pre-operative	7	57 53	55	<500 m
Post-operative	2.6	73 73	73	0.5 – 1 Km

Summary

Total No. of Cases Total No. of Knees	12 13
Relief of Pain	9 patients – mild or no pain 3 patients – uncomfortable pain
Range of Movement	100-120 degrees
'Knee Society' Knee Score Function Score	Excellent in 15% and Good in 62% Excellent in 31% and Good in 38%
Japanese Orthopaedic Association - Knee rating scale	Excellent in 31% and Good in 38%
Complications: Infection	2
Plate impingement causing pain	1
Under correction of varus	1

We have observed results in 13 knees with patients' age ranging between 35 to 54 years. Female patients outnumber the male patients by few percentage. Left sided knee gets involved in 69 % of the patients and for unkown reasons is symptomatic earlier in most of the patients.

On an average the Body mass index was 27.8 which is in overweight category. Two of the three obese patients had fair and poor

results. The relation of body weight to poor outcome could be attributed to the weight which the joint has to sustain and the poorer active rehabilitation by these patients.

Pain relief were found in Nine patients but for the 3 patients with complications of superficial infection in two and under correction in one. The outcome was excellent in 15%, good in 62%, fair in 15%, poor in 8% by 'Knee society' knee score and excellent in 31%, good in 38%, fair in 31% , no poor results by 'Knee society' function score. The outcome was excellent in 31%, good in 38%, fair in 15% and poor in 15% by JOA knee rating scale.

On an average the walking distance increased by 500 metres in the patients, had significant relief of pain while walking, squatting and sitting cross-legged and good functional outcome. About 5 patients who were heavy manual labourers returned to their previous job in 8 months.

Bone grafting was not done in 12 knees and good bone consolidation started in 3 months laterally and progressed to the medial side in 1 year. There were no cases of implant failure. Two patients had superficial infection, one had implant prominence and one had under correction of varus resulting in implant exit in 3 patients(23%).

DISCUSSION

In medial compartment osteoarthritis due to shifting of the weight bearing on the medial side of the knee will result in more cartilage destruction and subsequently varus deformity. Therefore, a unicompartmental knee replacement will not correct the alignment. A corrective osteotomy to alter the weight bearing axis will be ideal to slow down the degenerative process[6,7]. Many studies including one by Khan et al have stressed the effect of local alignment on osteoarthritis occuring in respective compartments after analysing 306 patients and 608 knees. They have found that one degree increase in varus angle was associated with increased risk of having medial compartment disease[46]. Raymond H.Kim has stated osteotomy as a reasonable option to treat active, physiologically young patients[8].

Although age is not a definitive criteria, the patients must be active enough to undergo rehabilitation and have good bone quality. Body weight is definitely an independent risk factor for complications.

Song et al have analysed the complications of 104 lateral closing wedge and 90 medial opening wedge osteotomies and stated that the latter had slightly lesser complication[11]. Luites et al stated that both types of osteotomies had equal fixation stability, pain relief and certainly

improved knee function, although the intended correction was achieved more likely with medial opening wedge technique[12] .

Initially, a number of plates were used and later locked plates came into being. Kolb et al have analysed good results with locked low-profile plates. They have analysed 51 medial open wedge osteotomies and found that 50 osteotomies healed in an average period of 3 months without bone grafts and had excellent grading in 57%, good in 24% patients by one rating system and 18% excellent, 63% good by another rating system[37].

Brouwer et al have used the puddu plate for opening wedge osteotomy and compared it with staples for closed- wedge osteotomy in overall 92 patients and have found that pain caused removal of puddu plate in 60% patients and removal of staples in 23% patients which is a significant difference. They have stated that closed wedge osteotomies have more accurate correction but both types have equal functional outcome at the end of 1 year[40].

Sen et al and Esenkaya et al have used puddu plate and plates with wedges respectively and showed that these plates provided better stabilisation to maintain the wedge and early mobilisation. Sen et al assessed 65 knees with osteotomies and found that it resolves pain and improves knee function significantly. But he has stressed that long term

studies are required in elderly patients to know whether the results are satisfactory[34].

Koshino et al have studied the effectiveness of high tibial osteotomy by the use of porous hydroxyapatite as a wedge and have stated to have good results and prevents collapse, but this study is not a comparative study. Bone grafts and substitutes are usually not necessary and we have observed that, all the patients in our study without bone grafting had good consolidation[10].

The results of total knee arthroplasty after osteotomy has variable results. Some studies state that there is no difference with primary arthroplasty whereas certain other studies like Haslam et al have showed slightly poorer results which are comparable to revision arthroplasty.The opening wedge, however, has the advantage of preserving the bone stock for future arthroplasty[9].

The excellent and good results seen in 15% and 62% by knee score, 31% and 38% by function score and JOA scores respectively seen in this study are comparable with results of Kolb et al and Sen et al.

The complications which are seen in this study could be prevented by proper pre operative planning and correct surgical technique. Infection control is also essential as the medial aspect of tibia is devoid of soft

tissues and proper postoperative care and rehabilitation is essential. 23% of patients had implant removal which is better compared with results of Brower et al.

The consolidation of the wedge occurred in all 12 of our patients without bone grafting in about 3 to 6 months. This is comparable to the results of Kolb et al.

This study has its limitations, as it is not a comparative study and the sample size of the study is small. As stated by Sen et al, long term studies are lacking in high tibial osteotomies and are necessary for more clear idea about the outcome. But, this short term study shows that osteotomy of the knee is definitely a viable option in unicompartmental osteoarthritis of the knee.

CONCLUSION

From our prospective study with thirteen knees we arrive at the following conclusions.

- Medial open wedge osteotomy is a useful option in unicompartmental osteoarthritis and definitely relieves pain and improves functional outcome in patients.
- The results are evident and maximal at 1 year.
- Bone grafting is not necessary for this procedure.
- No hazardous complications occur in these patients.
- Future Total knee replacement will not be a problem as the bone stock is preserved.

ANNEXURE

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MASTER CHART

S.No	Name	I.P. No	A/S	Occupation	BMI	Duration (yrs)	VAS		KS Score		JOA Score		Complications
							Pre	Post	Pre	Post	Pre	Post	
1.	Patient 1	84589	38/F	House wife	32.5	2	7	3	58 50	62 60	54	62	Sup. Infection
2.	Patient 2	76328	35/M	Labourer	22.5	3	8	2	62 60	79 90	58	81	-
3.	Patient 3	9145	39/F	House Wife	36.5	2	8	4	49 50	63 60	49	59	Sup. Infection
4.	Patient 4	13956	37/M	Lorry Driver	21.5	2	7	2	64 60	80 90	59	83	-
5.	Patient 5	24839	43/F	House maid	29.3	5	7	1	59 50	79 80	54	80	Implant prominence
6.	Patient 6	11636	40/F	Farmer	26.0	3	7	2	68 60	73 70	54	75	-

S.No	Name	I.P. No	A/S	Occupation	BMI	Duration (yrs)	VAS		KS Score		JOA Score		Complications
							Pre	Post	Pre	Post	Pre	Post	
7.	Patient 7 (Left) (Right)	27009	54/M	Community ambulator	23.1	7	8 7	4 2	51 40 52 40	57 60 74 60	48 53	59 69	Inadequate varus correction Lt knee
8.	Patient 8	36513	42/F	House wife	31.0	3	7	3	58 60	74 70	54	74	-
9.	Patient 9	74	47/M	Supervisor	29.4	5	6	2	60 60	83 90	59	80	-
10.	Patient 10	121	40/F	House hold worker	23.4	2	6	3	58 60	78 70	57	78	-
11.	Patient 11	184	37/M	Labourer	28.7	2	7	4	48 60	70 70	58	74	-
12.	Patient 12	28750	50/F	House wife	29.4	6	6	3	56 60	79 70	55	76	-

APPENDIX

Proforma :

Name of the Patient :

Age / Sex :

Occupation :

Body Mass Index :

Duration of Complaint :

Pre-operative

(a) Visual pain Analogue scale value :

(b) Knee Society Knee score value :

(c) Japanese orthopaedic association

Knee rating scale value :

(d) Radiographic Planning (Miniaci method)

Post-operative (Evaluation at 6 months, 1 year, 2 years)

(a) Visual pain Analogue scale value :

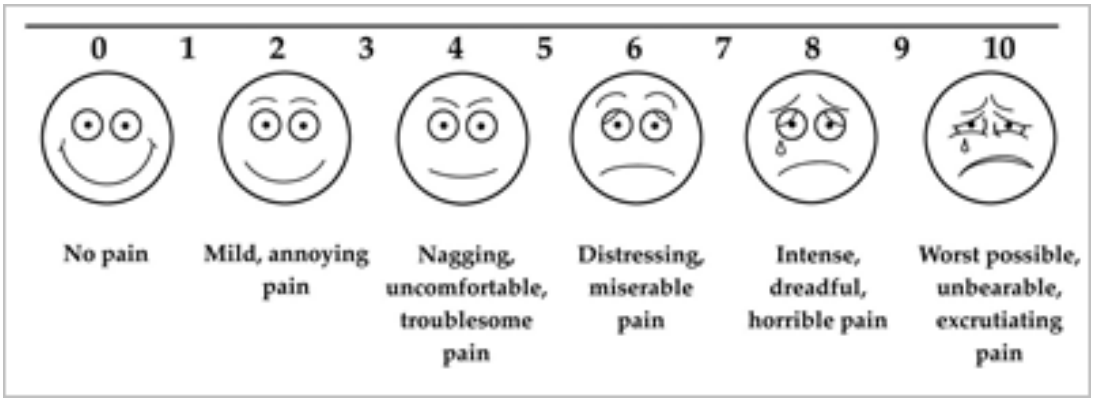
(b) Knee Society Knee score value :

(c) Japanese orthopaedic association

Knee rating scale value :

(d) Complications :

1. Visual Analogue Pain Scale



2. ‘Knee society’ knee score

Knee Society Score

Clinician's name (or ref) ..... Patient's name (or ref) .....

During the past 4 weeks ___ Click here for part 2 - FunctionScore

Part 1 - Knee Score

Pain

- None
- Mild / Occasional
- Mild (Stairs only)
- Mild (Walking and Stairs
- Moderate - Occasional
- Moderate - Continual
- Severe

Flexion Contracture (if present)

- 5°-10°
- 10°-15°
- 16°-20°
- >20°

Extension lag

- <10°
- 10-20°
- >20°

Total Range of Flexion

0-5	6-10	11-15	16-20	21-25
26-30	31-35	36-40	41-45	46-50
51-55	56-60	61-65	66-70	71-75
76-80	81-85	86-90	91-95	96-100
101-105	106-110	111-115	116-120	121-125

Alignment (Varus & Valgus)

0	1	2	3	4
		5 - 10		
11	12	13	14	15
		Over 15°		

Stability (Maximum movement in any position)

Antero-posterior	Mediolateral
<5mm	<5°
5-10mm	6-9°
10+mm	10-14°
	15°

Part 2 - Function

Walking

- ○ Unlimited
- ○ >10 blocks
- ○ 5-10 blocks
- ○ <5 blocks
- ○ Housebound
- ○ Unable

Stairs

- ○ Normal Up and down
- ○ Normal Up down with rail
- ○ Up and down with rail
- ○ Up with rail, down unable
- ○ Unable

Walking aids used

- ○ None used
- ○ Use of Cane/Walking stick deduct
- ○ Two Canes/sticks
- ○ Crutches or frame

Grading for the knee Society Score

Score 80-100 Excellent **Score 70-79** Good **Score 60-69** Fair **Score below 60** Poor

3. Japanese Orthopaedic Association - Knee rating scale for clinical evaluation of osteoarthritis of the knee

Pain (30 points)

No pain at any time	30
Mild starting pain	20
Moderate pain on walking	10
Severe pain on walking	5
Severe pain at rest	0

Function (20 points)

Walking unlimited	20
Walking distance of 0.5 to 1 km	15
Walking less than 0.5 km	10
Walking only indoors	5
Cannot walk	0

Range of motion (20 points)

More than 120°	20
119°-90°	15
89°-60°	10
59°-30°	5
Less than 30°	0

Flexion deformity (10 points)

0°-10°	10
11°-30°	5
More than 30°	0

Varus or valgus deformity (10 points)

Less than 5°	10
6°-15°	5
More than 15°	0

Activities of daily living (10 points)

Rising from chair

Climbing stairs

Going downstairs

One foot standing

Running

(2 points for easy; 1 point, difficult; 0 points, impossible in each item)

ETHICAL COMMITTEE APPROVAL

Ref. No. 5336 /E4/3/2012 Govt. Rajaji Hospital,
Madurai.20. Dated: .09.2012

Institutional Review Board / Independent Ethics Committee.
Dr. N. Mohan, M.S., F.I.C.S., F.A.I.S.,
Dean, Madurai Medical College & 2521021 (Secy)
Govt Rajaji Hospital, Madurai 625020.
Convenor
grhethicssecy @gmail.com.

Sub: Establishment-Govt. Rajaji Hospital, aMadurai-20-
Ethics committee-Meeting Agenda-communicated-regarding.

The Ethics Committee meeting of the Govt. Rajaji Hospital, Madurai was held at 12.00 Am to 1.30.Pm on 26.07.2012 at the Dean Chamber, Govt. Rajaji Hospital, Madurai. The following members of the committee have been attended the meeting.

1. Dr.N.Vijayasankaran,M.ch(Uro.) 094-430-58793 0452-2584397	Sr.Consultant Urologist Madurai Kidney Centre, Sivagangai Road,Madurai	Chairman
2. Dr.P.K. Muthu Kumarasamy, M.D., 9843050911	Professor & H.O.D of Medical Oncology(Retired)	Member Secretary
3. Dr.T.Meena,MD 094-437-74875	Professor of Physiology, Madurai Medical College	Member
4. Dr. S. Thamilarasi, M.D (Pharmacol)	Professor of pharmacology	
5.Dr.Moses K.Daniel MD(Gen.Medicine) 098-421-56066	Professor of Medicine Madurai Medical College	Member
6.Dr.M.Gobinath,MS(Gen.Surgery)	Professor of Surgery Madurai Medical College	Member
7.Dr.S. Dilshadh, MD(O&G) 9894053516	Professor of OP&Gyn Madurai Medical College	Member
8.Dr.S.Vadivel Murugan., M.D, 097-871-50040	Professor of Medicine Madurai Medical College	Member
9.Shri.M.Sridher,B.sc.B.L. 099-949-07400	Advocate, 2, Deputy collectors colony 4th street KK Nagar, Madurai-20.	Member
10.Shri.O.B.D.Bharat,B.sc., 094-437-14162	Businessman Plot No.588, K.K.Nagar,Madurai.20.	Member
11.Shri. S.sivakumar,M.A(Social) Mphil 093-444-84990	Sociologist, Plot No.51 F.F, K.K Nagar, Madurai.	Member

Following Projects were approved by the committee

Prof. Dr. P.V. PUGALENTHI
M.S. Ortho., D.Ortho.,
PROFESSOR & H.O.D.
Dept. of Orthopaedic Surgery,
Traumatology, & Rehabilitation
GOVT. RAJAJI HOSPITAL

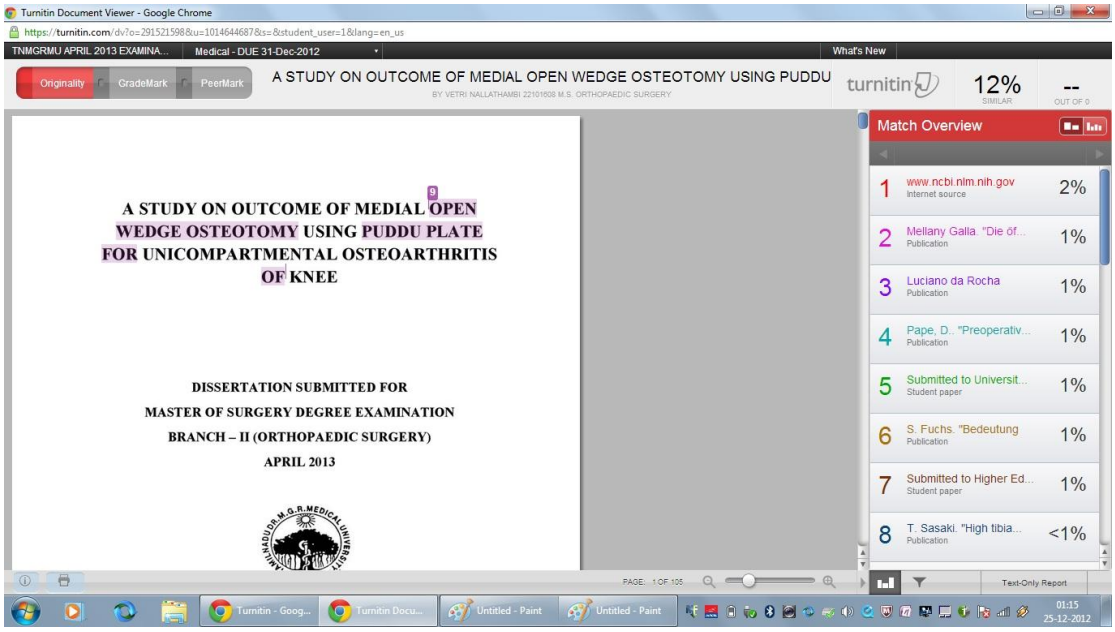
Sl. No	Name of P.G.	Course	Name of the Project	Remarks
1.	Dr. Vetri Nallathambi. R	M.S Ortho	Medial open wedge osteotomy using puddu plate for uni-compartmental ostcoarthritis knee.	Approved

Please note that the investigator should adhere the following: She/He should get a detailed informed consent from the patients/participants and maintain Confidentially.

1. She/He should carry out the work without detrimental to regular activities as well as without extra expenditure to the institution to Government.
2. She/He should inform the institution Ethical Committee in case of any change of study procedure site and investigation or guide.
3. She/He should not deviate for the area of the work for which applied for Ethical clearance.
She/He should inform the IEC immediately, in case of any adverse events pr Serious adverse reactions.
4. She/he should abide to the rules and regulations of the institution.
5. She/He should complete the work within the specific period and apply for if any
Extension of time is required She should apply for permission again and do the work.
6. She/He should submit the summary of the work to the Ethical Committee on Completion of the work.
7. She/He should not claim any funds from the institution while doing the word or on completion.
8.She/He should understand that the members of IEC have the right to monitor the work with prior intimation.

DEAN
8-9-12

To
All the above members and Head of the Departments concerned.
All the Applicants.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A STUDY ON OUTCOME OF MEDIAL OPEN WEDGE OSTEOTOMY USING PUDDU PLATE FOR UNICOMPARTMENTAL OSTEOARTHRITIS OF KNEE DISSERTATION SUBMITTED FOR MASTER OF SURGERY DEGREE EXAMINATION BRANCH – II (ORTHOPAEDIC SURGERY) APRIL 2013 THE TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY CHENNAI, TAMILNADU CERTIFICATE This is to certify that this dissertation entitled “A STUDY ON OUTCOME OF MEDIAL OPEN WEDGE OSTEOTOMY USING PUDDU PLATE FOR UNICOMPARTMENTAL OSTEOARTHRITIS OF KNEE” is the bonafide work done by Dr. R.VETRI NALLATHAMBI, under my supervision in the Department of Orthopaedic Surgery, Madurai Medical College, Madurai-20. Prof. Dr. P.V.PUGALENTHI, M.S Ortho., D. Ortho Professor and Head, Department of...